2008 Restoration Thinning Project Plan and Results

Compiled by the RT Project Team:
Rolf Gersonde
Amy LaBarge
Andrew Chittick
Sally Nickelson
Wendy Sammarco

and Compliance Consultant:
Jesse Saunders, International Forestry Consultants, Inc.

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Purpose of the Document
The 2008 Restoration Thinning Project Plan and Results document is intended to address multiple purposes. First, this document includes a brief overview about the restoration thinning program relative to the City's Cedar River Watershed (CRW) Habitat Conservation Plan (HCP). Second, it provides a brief overview of the restoration thinning candidate selection process. And finally, it provides a detailed summary of the restoration thinning work completed in 2008. This project plan is intended to function as an inclusive reference about the restoration thinning activities completed in the Cedar River Watershed in 2008.

1.0 Background – Restoration Philosophy

The focus of restoration should be towards restoring ecological functions and processes, which are dynamic in time, rather than seeking to restore a particular suite of ecological attributes that may be present at a specific point in time. In restoring a disturbed ecosystem, we seek creation of ecosystems that support and enhance natural ecological functions and processes, even though these are not always well understood. We need to be thoughtful and explicit about what ecological functions and processes we are attempting to restore (Chapin et al. 2004).

It is difficult to measure the key processes and functions in the natural environment. Therefore, in our restoration efforts we try to provide, enhance or emphasize the components or attributes that we assume to be necessary to support particular processes or functions. In more specific terms, we can alter the current tree and most vegetation growing conditions through our restoration thinning efforts and expect that the 'restored' habitat will be utilized now and into the future. We anticipate that by manipulating attributes (e.g. prescribing different tree densities and tree spacing patterns) across the previously altered landscape we are facilitating opportunities for key processes and their associated functions (such as complex forest habitat) to occur (see the Upland Forest Habitat Restoration Strategic Plan, 2008, for a more detailed discussion).

1.1 HCP Commitment

The writers of the HCP intended the restoration thinning program to address those areas within the CRW that had been harvested in the recent past (1970-present; approximately 30 year old and younger trees). The 50-year HCP committed fifteen years of funding to implement the restoration thinning program, within which time at least 10,480 acres of restoration thinning will have been treated.

1.2 Restoration Thinning Goals and Objectives

Upland restoration thinning is the thinning of dense second-growth forest areas generally less than 30 years of age that have relatively low biological diversity and are in or approaching the competitive exclusion stage of forest succession. The overarching goal of restoration thinning is to accelerate the development of complex habitat in the near-term and nudge the treated area forward toward development of late-successional and old-growth forest conditions in the long-term. More specific objectives of restoration thinning include:

- reduce competition among trees;
- increase light penetration;
- stimulate tree growth;
- increase tree and understory plant species diversity;
- reduce long-term fire hazard;
- minimize the chance of catastrophic windthrow, insect, or disease outbreak;
- accelerate forest development past the competitive exclusion stage to a more biologically diverse stage, and/or;
- extend the stand initiation period such that more diverse species and stand structures become established.

2.0 The Restoration Thinning Candidate Pool

In order to identify remaining restoration thinning candidates in the CRW, a new system was developed in 2006 that incorporated remote sensing image data and a landscape-scale prioritization scheme.

Approximately 6000 acres had already been treated with restoration thinning to date, and there was a need to better identify and prioritize the remaining acres. This section of the report describes how the restoration thinning candidate pool was created.

2.1 Identifying the Candidates

In 2006, the restoration thinning units were identified utilizing LiDAR data, which provides both ground surface imagery and vegetation surface imagery. The LiDAR ground surface model provides excellent topographic information, and when combined with the vegetation surface images it can provide information on average canopy height. Based on safety considerations, it was determined that the restoration thinning candidate pool would include stands of trees whose average canopy height was less than or equal to thirty feet (and greater than 3 feet tall to eliminate noise associated with the LiDAR data and shrubby areas). The LiDAR analysis identified just over 12,000 acres in this pool, which is more than can be realistically treated in the HCP restoration thinning program by 2015.

2.2 Prioritizing the Candidates

Ecologists who work in the CRW struggle with how to prioritize restoration activities. In other words, where should restoration activities occur first and why during the implementation of the 50-year HCP. A landscape-scale prioritization effort (the Landscape Synthesis Plan) was initiated by watershed staff in 2005 that facilitated the identification of high priority areas for restoration (Erckmann et al. 2008). The resulting GIS layer, called the Synergy Layer, identifies the highest synergy areas where there are overlaps among water bodies and their associated riparian areas, old-growth forests and high functioning second-growth forests, and special habitats such as wetlands, rock outcrops, and talus slopes.

The Synergy Layer was overlaid with the LiDAR derived restoration thinning candidate pool map (stands with 3-30 foot average canopy height), for the purpose of ranking the restoration thinning candidates (previously identified 12,000 acres). Simply put, the restoration thinning unit ranked one has the greatest potential to provide important habitat improvement with appropriate restoration activities based on its nearness to high synergy areas.

To better understand current restoration thinning candidate composition, field data collection has been conducted in the lowest numbered candidates in order to provide real stand data. This field data collection includes tree measurements (species, height, diameter, density), plant association determination, and historic stand information (stump species, diameter, density). Practically speaking, all of the candidates under number 100 may be considered for restoration thinning, and a large portion of those will actually be thinned depending on their current conditions (e.g., tree density, tree sizes, species composition, patchiness).

2.3 Sequencing Restoration Thinning with Road Decommissioning

The HCP road decommissioning program focuses on removing roads in the CRW that are determined to be unnecessary for current or future operations as well as removing roads that cause sediment contributions to water bodies. Coordinating restoration thinning activities with the road decommissioning program is necessary to implementing restoration thinning cost-effectively, efficiently, and safely. Prioritizing restoration thinning units in an area identified for road decommissioning makes better sense than decommissioning the road and sometime in the future requiring the contractor to walk the decommissioned road to access the restoration thinning unit. Some of 2008 restoration thinning units were selected to compliment road decommissioning planned for 2009.

3.0 Objectives for 2008 Restoration Thinning

As in years past, the ecological objectives for restoration thinning include: accelerating the forest development pathway through the stem exclusion stage, maintaining or increasing the growth rate of trees, facilitating future recruitment of large diameter snags and coarse woody debris, increasing plant species diversity, protecting special habitats, and protecting water quality. The prescriptions for 2008 restoration thinning treatments continue to focus on these ecological objectives and include these additional objectives:

- Designing and implementing restoration thinning treatments to provide for varying forest stand structures and development pathways;

- Targeting slash treatments (lopping) in units with larger trees;
- Providing connectivity/proximity to old growth and special habitats;
- Enhancing near term benefits to old growth and special habitats (wide spacing adjacent to older forest, snow gaps intended to promote increased seasonal filtration to adjacent wetland lands);
- Minimizing habitat fragmentation;
- Improving elk and deer winter range habitat;
- Minimizing sediment production through road decommissioning and restoration.

3.1 Phases of 2008 Restoration Thinning Work

2008 Restoration thinning was designed as two phases for contract advertisement and work completion and consisted of forty-four units totaling 697 acres. Additionally, two units totaling forty-three acres associated with Phase two of the 2008 restoration thinning were identified as leave units, requiring no treatment. Phase One included three units totaling forty acres (*see note at bottom of Table 1). Phase One's Imagine unit was actually begun in 2007 (five acres completed in 2007) and due to early and persistent snow in the lower watershed was unable to be completed in 2007. Phase Two consisted of forty-one units, totaling 644 acres. Phase Two units were located in the upper watershed in both the north fork Cedar basin and the upper Lindsay Creek basin. Access to the upper Lindsay basin units was problematic in 2008 due to an impressive accumulation of snow and two road blocking landslides. The snow persisted on the roads until July 2008 and the landslides required heavy equipment and skilled operators to carefully clear the roads. Additionally, Phase Two had seasonal timing restrictions and could not be implemented until September 1, due to marbled murrelet and northern goshawk activities in the vicinity.

The 2008 units varied in size from 2 acres to 78 acres. The majority of the 2008 restoration thinning work occurred in the upper watershed with only one unit occurring in the lower watershed. Table 1 provides 2008 restoration thinning information regarding unit numbers, acres, sub-basin locations, treatment, and phase.

Table 1. 2008 Restoration thinning unit numbers, acres, location, treatment and phase

Unit #	Acres	Sub-basin location	Treatment	Phase
Imagine	35*	Main stem Cedar River	Thinning with skips and gaps	1
9.1	15	North Fork Cedar River	Thinning with skips	2
9.2	10	North Fork Cedar River	leave	2
9.3	5	North Fork Cedar River	Thinning with skips	2
18.1	39	Lindsay Creek	Thinning with skips and gaps, lop slash in gaps and plant	2
18.2	43	Lindsay Creek	Thinning with skips and gaps	2
18.3	10	Lindsay Creek	Thinning with diameter limit	2
18.4	33	Lindsay Creek	Snag patches	2
24.1	5	Lindsay Creek	Thinning with skips and gaps	2
24.2	33	Lindsay Creek	Thinning with skips and gaps	2
24.3	13	Lindsay Creek	Thinning with skips and gaps	2
24.4	3	Lindsay Creek		2
24.5	4	Lindsay Creek	Thinning with skips and gaps	2
24.6	9	Lindsay Creek	Thinning with skips and gaps	2

24.7	2	Lindsay Creek		2
24.8	22	Lindsay Creek	Snow retention gaps	2
24.9	15	Lindsay Creek	Thinning with skips and gaps	2
36.1	8	North Fork Cedar River	Thinning with skips and gaps	2
36.2	25	North Fork Cedar River	Thinning with skips and gaps	2
36.3	15	North Fork Cedar River	Thinning with skips and gaps	2
36.4	2	North Fork Cedar River	Thinning with skips	2
61.1A	8	Lindsay Creek	Thinning with diameter limit	2
61.1B	35	Lindsay Creek	Thinning with skips and gaps	2
61.1C	23	Lindsay Creek	Thinning with diameter limit	2
61.2	23	Lindsay Creek	Thinning with skips and gaps	2
61.3	3	Lindsay Creek	Thinning with diameter limit	2
61.4A	29	Lindsay Creek	Thinning with skips and gaps	2
61.4B	2	Lindsay Creek	Thinning with diameter limit	2
61.4C	4	Lindsay Creek	Thinning with diameter limit	2
61.5	30	Lindsay Creek	Variable thinning with skips and gaps	2
61.6	33	Lindsay Creek	leave	2
61.7	13	Lindsay Creek	Thinning with skips and gaps	2
61.8	78	Lindsay Creek	Thinning with skips and snag patches	2
61.8A	4	Lindsay Creek	Snow retention gaps	2
61.8B	3	Lindsay Creek	Snow retention gaps	2
61.8C	3	Lindsay Creek	Snow retention gaps	2
61.8D	3	Lindsay Creek	Snow retention gaps	2
61.8E	4	Lindsay Creek	Snow retention gaps	2
61.9	15	Lindsay Creek	Thinning with skips and gaps	2
61.10	11	Lindsay Creek	Thinning with skips and gaps	2
61.11	56	Lindsay Creek	Snag patches	2
61.12	14	Lindsay Creek	Variable thinning with skips	2

*note: The Imagine unit is forty acres total, five of those acres were completed in 2007.

3.2 Work Planning

A project team including Forest Ecology staff (Wendy Sammarco project lead, Amy LaBarge, Rolf Gersonde, Andy Chittick), Fish and Wildlife staff (Sally Nickelson), and GIS staff (Mark Joselyn) worked collectively on the 2008 restoration thinning. The team identified 2008 restoration treatment areas based on the candidate pool rankings and road decommissioning plans for 2009. Additionally, units planned for 2007 that were not completed in 2007 were added to the 2008 restoration thinning project. The team utilized stand data collected in 2006 from proposed restoration thinning units, pondered unit landscape locations and basin connectivity and identified unique habitat features relative to unit locations for the purpose of refining unit boundaries. Identification of individual unit boundaries was followed by development of management objectives and prescriptions for each unit. Additionally, expertise and input was sought from the Forest Hydrology group (Dave Beedle, Todd Bohle) and Fish and Wildlife group (Dwayne Paige, Heidy Barnett) to guide prescription development. The Muckleshoot Indian Tribes wildlife biologists also provided additional review and input. Once the work packages for each phase were complete, they were reviewed by key staff who provided comments. The reviewed and adjusted work packages were then advertised and awarded to restoration thinning contractors in the established vendor pool.

4.0 Unit Summary

This section provides the following information specific to each unit:

- Unit history and context;
- Site specific objectives;
- Prescriptions, which include information on species preferences, thinning treatments, skips, gaps, planting and slash treatment;
- Post-treatment results.

Note that for the most part the prescriptions are written in future tense, as they were to be implemented, while post-treatment results are written in past tense.

Unit maps are included for each 2008 restoration thinning unit in Appendix A. An example of a 2008 restoration thinning contract is included in Appendix B.

4.1 Phase One

Three adjacent units (Imagine) comprised Phase One. Imagine was a unit that had been awarded but not completed in 2007. Five acres of restoration thinning was completed in the Imagine unit in 2007, the remaining 35 acres were completed in 2008. The prescriptions for the Imagine Units changed in 2008, based on wildlife habitat suggestions from Seattle Public Utilities CRW wildlife biologists and Muckleshoot Indian Tribe wildlife biologists. These prescription changes added gaps, connecting corridors between the gaps, and slash treatment within the gaps for winter range improvement for ungulates. Bids were awarded on May 2, 2008 for the Imagine unit in Phase One. The contract work was completed by August 5, 2008.

Unit 1.1A, 1.1B, and 1.2 (Imagine) (40 acres)

location: lower watershed

Unit History and Context

The area was initially harvested in approximately 1920 and it is assumed trees were allowed to regenerate naturally. A commercial thinning occurred in 1986, when the stand was roughly 66-years-old. The commercial thinning objective was to remove the suppressed and poor quality trees as well as spacing out the remaining trees with the intention of a future harvest (the basal area target is unknown). A commercial variable retention harvest occurred in 1994, when the stand was 74-years-old. This 1994 variable retention harvest design left part of the stand in thinned wedges with regeneration harvest in between. The thinned wedges suffered significant blow-down after the 1994 harvest, and salvage of the blown down trees occurred. The area was planted with Douglas-fir and western red cedar seedlings in 1995. Western hemlock naturally regenerated.

In 2006, staff collected data on trees per acre, diameters and species composition the Imagine area, as shown in Table 2.

Table 2. Imagine Unit 2006 pre-treatment information*

Type	Trees per acre
Total number of trees	10,077
Western hemlock, 6" dbh or smaller	9,747
Douglas-fir, 5" dbh or smaller	187
Western red cedar, 3" dbh or smaller	127
Red alder, 2" dbh or smaller	16

*sample information: Twelve plots were measured.

The following Tables include contract specifications for the Imagine Unit: tables 3,4 & 5. Additionally, a report: Restoration Thinning, Imagine Unit, 2008 Benefits for Elk Habitat, written by Sally Nicholson is included in Appendix C.

Table 3. Imagine Unit 1.1 A Objective and Prescription

Unit # 1.1A Imagine	Prescription	Acres
Objective	• Promote tree growth while providing variability across 40 acre area • Promote winter range opportunities for ungulates • Preserve hardwood dominated environment surrounding spur roads	
General	• Cut no trees that are 6" dbh or greater • Cut all western hemlock that are less than 6" dbh except when no other suitable species is available to meet spacing requirements • Leave all hardwood tree species, ignore them for spacing purposes • All western red cedar will be left except if found in clumps. The clump will be thinned to leave one dominant cedar.	
Skips	• The areas within approximately 50' of the edge of spur roads and landings are flagged and posted to be left un cut and not included in the acreage to be spaced	
Gaps	• Create two 100 foot diameter gaps in locations indicated on the map	0.4
Spacing	• Thin the remaining unit to 18'x18' spacing (134 trees per acre)	12
Slash	• Lop and pile all thinning slash in the gaps	0.4

Table 4. Imagine Unit 1.1 B Objective and Prescription

Unit # 1.1B Imagine	Prescription	Acres
Objective	• Promote tree growth while providing variability across 40 acre area • Promote winter range opportunities for ungulates • Preserve hardwood dominated environment surrounding spur roads • Reduce thinning slash related fire hazard by lopping slash adjacent to 70 Road	
General	• Cut no trees that are 6" dbh or greater • Cut all western hemlock that are less than 6" dbh except when no other suitable species is available to meet spacing requirements • Leave all hardwood tree species, ignore them for spacing purposes • All western red cedar will be left except if found in clumps. The clump will be thinned to leave one dominant cedar.	
Skips	• The areas within approximately 50' of the edge of spur roads and landings are flagged and posted to be left un cut and not included in the acreage to be spaced	
Gaps	• Create one 100 foot diameter gaps in locations indicated on the map	0.2
Spacing	• Thin the remaining unit to 18'x18' spacing (134 trees per acre)	5
Slash	• Lop and pile all thinning slash in the gap • Lop all slash within 100' of the 70 road	

Table 5. Imagine Unit 1.2 Objective and Prescription

Unit # 1.2 Imagine	Prescription	Acres
Objective	• Promote tree growth while providing variability across 40 acre area • Promote winter range opportunities for ungulates • Preserve hardwood dominated environment surrounding spur roads • Reduce thinning slash related fire hazard by lopping slash adjacent to 70 Road	
General	• Cut no trees that are 6" dbh or greater • Cut all western hemlock that are less than 6" dbh except when no other suitable species is available to meet spacing requirements • Leave all hardwood tree species, ignore them for spacing purposes • All western red cedar will be left except if found in clumps. The clump will be thinned to leave one dominant cedar.	
Skips	• The areas within approximately 50' of the edge of spur roads and landings are flagged and posted to be left un cut and not included in the acreage to be spaced	
Gaps	• Create four 100 foot diameter gaps in locations indicated on the map	0.8
Spacing	• Thin the remaining unit to 15'x15' spacing (194 trees per acre)	23
Slash	• Lop and pile all thinning slash in the gaps • Lop all slash within 100' of the 70 road	

Post Treatment

Imagine

The three units that make up Imagine were completed according to the prescriptions. Attention was paid to apply the prescribed gap diameters, all 100 feet. There is black bear evidence in the Imagine Unit, with a den being observed (not in use). The Douglas fir that are growing in this unit are not large enough to be of interest to bear; however this may change and bear damage may occur as the trees increase in diameter. The gaps and the corridors connecting the gaps were created in part to provide browse and mobility options for ungulates. In the late summer of 2008, following thinning, deer pellets (poop) were observed in the corridors.

The forest that was thinned was growing under extremely tight growing space conditions which resulted in poor height diameter ratios on many trees. While the thinners attempted to chose the best available tree, a higher than normal mortality rate in the thinned trees may occur because of this poor height diameter issue, particularly in unit 1.2.

In the fall of 2008 volunteers were invited to assist with planting the Imagine Units gaps. The planting objectives were to increase plant diversity and provide current and future browse opportunities for ungulates. Post treatment data is summarized in Table6 and a map of the Imagine Unit is located in Appendix A.

Table 6. Post Treatment Imagine Unit

Type	Average number of trees per acre
Total number of trees all units	178
Unit 1.1A	217
Unit 1.1B	156
Unit 1.2	161

Sample information 1.1A sample size 3; 1.1B sample size 9; 1.1C sample size 5

4.2 Phase Two

Forty-one units comprised phase two. The restoration thinning contract work for phase two was advertised and awarded in August 2008. The thinning work began the first week of September. Typically, restoration thinning in the Cedar River Watershed is performed annually and begins in May or June, weather being the limiting factor (snow level). Relative to the weather, 2008 was an unusual year. The watershed received abundant snowfall throughout 2007 and into 2008, the latest snow fall happened in April of 2008. Access to

Phase two units was limited by all this snow accumulation, on the roads and in the units. In fact, as late as August 2008, there was still snow lingering within the units in the Lindsay Creek basin. Besides snow on the roads, access to the Lindsay Creek basin was problematic due to two large avalanches which deposited snow and tree debris completely blocking the two access routes. In August the operations crew at the Cedar River Watershed cleared the avalanche related debris and plowed the remaining snow off the access to Lindsay, allowing restoration thinning 2008 to progress.

The phase two units were awarded to three different contractors. These three contractors promptly got to work and completed all phase two work before the late 2008 snows began.

Unit 9.1, 9.2 & 9.3 (30 acres)
Location: Upper Watershed
Unit History and Context
Units 9.1,9.2 &9.3 were clear-cut harvested by a USFS contractor around 1984 and apparently planted with Douglas fir seedlings about 1985 (planting information unavailable). Clear-cut harvesting of two other units by the USFS in this section (section 10 of Township 21N Range 10 east) occurred at approximately the same time (within five to ten years of each other). It appears that approximately 80% of this Section 10 was clear-cut harvested while the remaining approximately 20% consists of original forest. Approximately eighty acres of original forest (old growth) is located adjacent and directly to the north of these units. The southwestern boundary of Unit 9.1 is adjacent to an original forest riparian buffer on the North Fork of the Cedar River; however there is no riparian buffer in the portion of unit 9.1 and 9.2 & 9.3 that is adjacent to a tributary to the North Fork of the Cedar River.

An operational restriction, because of potential marbled murrelet (Brachyramphus marmoratus) nesting habitat , required restoration thinning to occur after August 31. The noise from chainsaw operations would not conflict with murrelet nesting if begun after August 31. Pre-treatment data for this area was collecting in 2006 and is summarized in Table 7.

Table 7. Unit 9 2006 pre-treatment information

Type	Average number of trees per acre
Total number of trees	667
Western hemlock, 0-3" dbh	250
Douglas fir, 2.3-5.0" dbh	350
Silver fir, 3-6" dbh	67

*sample information: six plots were measured.

Unit 9.1 is 15 acres, unit 9.2 is 10 acres and unit 9.3 is 5 acres. Unit 9.2 has what appears to be a tendency towards natural patchiness in tree distribution therefore unit 9.2 will be a leave unit with no further treatment planned. The objectives and prescriptions for unit 9.1 and unit 9.3 are located in Table 8 and Table 9.

Table 8. Unit 9.1 Objectives and Prescription

Unit # 9.1	Prescription/Contract Requirements	Acres
Objective	? Promote tree growth while providing variability across 30 acre area ? Create long range opportunities for increased marbeled murrelet habitat while not jeopardizing current marbled murrelet nesting through timing restrictions	
General	? Locate and flag skips as indicated on map ? Fall all trees away from natural openings and meadows	
Skips	? Install eight 1/10th acre skips (74' diameter) ? Install four 1/5th acre skips (105' diameter)	0.8 0.8

	? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	
Spacing	? Thin the remaining unit to 16'x16' spacing (170 tpa) ? Leave all trees that are 6"dbh or greater; ignore for spacing purposes ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing	15 acres

Table 9. Unit 9.3 Objectives and Prescription

Unit # 9.3	Prescription/Contract Requirements	Acres
Objective	? Promote tree growth while providing variability across 30 acre area ? Create long range opportunities for increased marbeled murrelet habitat while not jeopardizing current marb led murrelet nesting through timing restrictions	
General	? Locate and flag skips as indicated on map ? Fall all trees away from natural openings and meadows	
Skips	? Install five 1/10th acre skips (74' diameter) ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	0.5
Spacing	? Thin the remaining unit to 16'x16' spacing (170 tpa) ? Leave all trees that are 6"dbh or greater; ignore for spacing purposes ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing	5 acres

<u>Unit 18.1,18.2,18.3 & 18.4 (125 acres)</u>
Location: Upper Watershed
Unit History and Context
Units 18.1,18.2,18.3 & 18.4 (unit 18) are located in the upper Lindsay Creek basin. Lindsay Creek is a tributary to the Rex River. Records indicate that the area that comprises unit 18 was clear-cut harvested between the years of 1966 and 1972, a six year period. The unit 18 areas identified as restoration thinning candidates by LiDAR data analysis are dominated by silver fir, therefore it is assumed that these areas were allowed to regenerate naturally. Table 10 provides pre-treatment summary data. Original forest (old growth) borders unit 18 to the north and west.. All the sub-units that comprise unit 18 have streams flowing through them with associated riparian habitat.

Elk and black bear were observed frequently in this area.

Table 10. Unit 18 2006 pre-treatment information

Type	Average number of trees per acre
Total number of trees	9,563

Western hemlock, 0 dbh	313
Silver fir, 1-1.8" dbh	9,250

*sample information: four plots were measured.

Unit 18.1 is 39 acres; Unit 18,2 is 43 acres; Unit 18.3 is 10 acres and Unit 18.4 is 33 acres. A map of these units is located in Appendix A. Segments of the streams that flow through units 18.2 and 18.3 were identified for a riparian vegetation experiment. These riparian experiment areas were not treated as part of this phase two restoration thinning contract. Information about the riparian experiment can be found in Appendix D. The objectives and prescriptions for units 18.1, 18.2, 18.3 & 18.4 are located in Table 11, 12, 13 & 14.

Table 11. Unit 18.1 Objectives and Prescription

Unit # 18.1	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir dominance, increase tree species diversity to facilitate future spotted owl nesting habitat, increase gappiness in homogeneous stands, limit surface erosion to streams and maintain stream shade, protect and enhance amphibian habitat along streams. Provide shaded habitat connectivity between old-growth forest and streams. Provide future habitat connectivity between old-growth patches. Conduct a riparian thinning experiment to evaluate different riparian thinning prescriptions.	
General	? Locate and flag skips and gaps as indicated on map. Note that some skips and gaps are adjacent to each other. ? Fall all trees away from natural openings, meadows, created gaps, skips, and streams	
Skips	? Install twenty 1/10th acre skips (74' diameter) ? Install a 50' wide stream skip in areas located on the map and encompassing confluence of streams. Note the skip changes from one side to the other along the stream. ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	2 1.9
Gaps	? Install twelve 1/10th acre gaps (74' diameter) in the vicinity of the streams ? Install twenty-two 1/5th acre gaps (105' diameter) ? Flag all gaps with orange flagging ? All gaps must be located in forested areas, not in existing natural gaps ? Cut all trees in gaps, except hardwoods, cedar, or western white pine	1.2 4.4
Slash	? To create plantable spots, lop and pile thinning slash in gaps or scatter lopped slash outside of gaps. Do not pile slash along the edges of the gaps.	5.6
Spacing	? Thin the remaining unit to 15'x15' spacing (194 tpa) ? girdle trees 7-10" dbh ? cut no trees 10" dbh and greater; ignore for spacing purposes ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western	

	hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing	39

Table 12. Unit 18.2 Objectives and Prescription

Unit # 18.2	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir dominance, increase gappiness in homogeneous stands, limit surface erosion to streams and maintain shading, promote tree growth, provide corridor between older forest and streams for amphibian use. Provide future habitat connectivity between old-growth patches. Conduct a riparian thinning experiment to evaluate different riparian thinning prescriptions.	
General	? Locate and flag skips and gaps as indicated on map. Note that some skips and gaps are adjacent to each other. ? Fall all trees away from natural openings, meadows, created gaps, skips and streams	
Skips	? Locate and flag 50' wide stream skip as indicated on map. Note the skip changes from one side to the other along the stream (marked in blue on map). 0.9 ? Locate and flag 100' wide linear skip adjacent to unit 18.1 2.4 ? Locate and flag 150' wide skip connecting older forest to the west and unit 18.3 1.6 ? Install fourteen 1/10th acre skips (74' diameter) 1.4 ? Install six 1/5th acre skips (105' diameter) 1.2 ? Locate and flag 100' wide (each side) skips along streams indicated on unit map. This will be a future riparian exp eriment. ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	
Gaps	? Install fourteen 1/10th acre gaps (74' diameter) 1.4 ? Install six 1/5th acre gaps (105' diameter) 1.2 ? Flag all gaps with orange flagging ? All gaps must be located in forested areas, not in existing natural gaps ? Cut all trees in gaps, except hardwoods, cedar, or western white pine	
Spacing	? Thin remaining unit to 18'x18' spacing (134 tpa), except riparian experiment area (flagged pink boundary) ? girdle trees 7-10" dbh ? Cut no trees 10" dbh or greater; ignore for spacing purposes ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing	

	? Apply inner gorge standard prescription on stream located as boundary between unit 18.2 and 18.3: no trees may be cut within an inner gorge. Trees above the upper break of the inner gorge that are within 25 feet of the upper break will be thinned to 10x10 foot spacing.	43

Table 13. Unit 18.3 Objectives and Prescriptions

Unit # 18.3	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir dominance, increase gappiness in homogeneous stands, limit surface erosion to streams and maintain shading. Conduct a riparian thinning experiment to evaluate different riparian thinning prescriptions.	
General	? Fall all trees away from natural openings, meadows, and streams	
Skips	? Locate and flag 100' wide (each side) skips along streams indicated on unit map. This will be a future riparian experiment. ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	xxxx
Gaps	? No gaps in this unit	
Spacing	? Cut only silver fir, all other species will be ignored for prescription purposes ? Leave all trees that are 5" dbh and greater in size. All trees smaller than 5" will be cut ? if no 5" trees are present thin the smaller trees to 18'x18' spacing (134 tpa), except riparian experiment area (flagged pink boundary) ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, alaska yellow cedar or hardwoods and ignore for spacing	10

Table 14. Unit 18.4 Objectives and Prescriptions

Unit # 18.4	Prescription/Contract Requirements	Acres
Objective	? Promote for dominant tree growth characterisitics through gap edge trees and the one tree in the center of the gap. Provide short-term small diameter snag habitat for snag-dependent species. Increase gappiness in homogeneous stand. Conduct a riparian thinning experiment to evaluate different riparian thinning prescriptions.	

General	? Locate and flag gaps as indicated on map ? Fall all trees away from natural openings, meadows or created gaps	
Skips	? Locate and flag 100' wide (each side) skips along streams indicated on unit map. This will be a future riparian experiment. ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	xxxx
Gap/Snag Patches	? Install twenty 1/10th acre snag gaps (74' diameter) ? Flag all gaps with red flagging ? All gaps must be located in forested areas, not in existing natural gaps ? Within gaps, girdle all trees in gaps that are greater than 7" dbh and cut all trees smaller than 7"dbh. ? Within each gap leave the one largest live tree near the center of the gap ? Leave tree priority shall be: (1) western white pine, (2) western red cedar, (3) any hardwood, (4) noble fir, (5) Douglas-fir, (6) western hemlock, (7) silver fir	2
Spacing	? No thinning in the remaining unit	33

Post Treatment

Unit 18.1

The project team considered the pre-treatment data when crafting the prescriptions for unit 18.1. The pre-treatment data indicated that this unit is dominated by silver fir; in fact, 97% of the pre-treatment species composition was silver fir, and 3% western hemlock. Because of this silver fir dominance, the concept of creating plantable gaps for the purpose of introducing several other conifer species to this area was prescribed. While other densities of gaps was experimented with visually through GIS exercises (30%, 15% and 14% of unit 18.1 in gaps), it was determined that designing a 14% gap overlay on this unit of 39 acres was most visually appealing to the project team. These gaps were planted in October of 2008 with Douglas fir, western white pine, western red cedar and noble fir. The gaps and skips are not reflected in table 15; however their approximate locations are on the map of unit 18 in Appendix A.

Table 15. Unit 18.1 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	157
silver fir, 5-14” dbh	132
Western hemlock, 5-7” dbh	25
Western red cedar, 2-3” dbh	25

*sample information: ten plots were measured.

Unit 18.2

The unit boundaries for 18.2 included an area designated for a future riparian experiment. The prescription included circular skips and gaps. Linear skips are also part of the prescription intending to provide undisturbed connections between older forest edges to riparian areas. Table 16 provides post-treatment summary data, and the unit map is located in Appendix A.

Table 16. Unit 18.2 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	150
silver fir, 4.2-9.4" dbh	117
Noble fir, 4.7-8.5" dbh	25
Western hemlock, 5.5" dbh	8

*sample information: six plots were measured.

Unit 18.3

The unit boundaries for 18.3 included an area designated for a future riparian experiment similar to unit 18.2. The prescription for unit 18.3 required only silver fir that was less than 5 inches dbh to be cut. This prescription resulted in a unit that varies between areas that are fairly open to areas that are densely populated with trees, particularly western hemlock. This variability is not adequately captured in the post-treatment data; however it is included in Table 17.

Table 17. Unit 18.3 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	300
silver fir, 4.8-8.9" dbh	225
Western hemlock, 2.4 - 5.2" dbh	75

*sample information: two plots were measured.

Unit 18.4

The trees in unit 18.4 were considered too tall to restoration thin safely and too small to be considered for an ecological thinning. The road access from above (209 road) and the road access from below (250 road) are being considered for decommissioning. Because unit 18.4 is perceived as densely stocked, with minimal canopy complexity and with limited future access, the restoration thinning project team created the prescription of introducing snag patches to this unit. These snag patches are intended to add diversity to the canopy and provide near term habitat opportunities. The diameter of the snag patches is approximately two times the current height of the trees, in this case 74' ($1/10^{th}$ acre). Snag patch size based on two times the average surrounding tree height or greater allows for less shading throughout the patch from the surrounding leave trees. The reason for the name snag patches is that trees that are greater than 7" diameter occurring within the designated snag patch will be girdled. These girdled trees may provide short term habitat (feeding and perhaps nesting) for some bird species. Also, the green tree left in the center of the snag patch and the edge trees surrounding the snag patch may develop into trees with dominant canopy characteristics. The contractors performed the work as prescribed in unit 18.4; however, measures of their success do not easily lend itself to a post-treatment summary table.

Unit 24.1, 24.2, 24.3, 24.4, 24.5, 24.6, 24.7, 24.8, &24.9 (106 acres)

Location: Upper Watershed

Unit History and Context

Units 24.1, 24.2, 24.3, 24.4, 24.5, 24.6, 24.7, 24.8, &24.9 (unit 24) are located in the upper Lindsay Creek basin. Lindsay Creek is a tributary to the Rex River. Records indicate that the area that comprises unit 24 was clear-cut harvested between the years of 1959 and 1978, a nineteen year period. The unit 24 areas identified as restoration thinning candidates by LiDAR data analysis are dominated by silver fir, therefore it is assumed that these areas were allowed to regenerate naturally. Table 18 provides pre-treatment summary data. Original forest (old growth) borders unit 24 to the northwest and southeast. Some of the sub-units that comprise unit 24 have streams and associated wetlands with associated riparian habitat.

Black bear were observed frequently in this area.

This unit is on the southern ownership boundary and the southern hydro-graphic boundary of the CRW. Adjacent to the CRW ownership and to the south is industrial forestland. All of this adjacent forestland has been harvested (no older forests to the south).

Table 18. Unit 24 2006 pre-treatment information

Type	Average number of trees per acre
Total number of trees	2,500
Western hemlock, 1-3" dbh	167
Silver fir, 1-3" dbh	1,583
Noble fir, 5-11" dbh	750

*sample information: six plots were measured.

Unit 24.1 is 5 acres; Unit 24.2 is 33 acres; Unit 24.3 is 13 acres, Unit 24.4 is 3 acres, Unit 24.5 is 4 acres, Unit 24.6 is 9 acres, Unit 24.7 is 2 acres, Unit 24.8 is 22 acres and Unit 24.9 is 15 acres. A map of these units is located in Appendix A. The objectives and prescriptions for units 24.1, 24.2, 24.3, 24.4, 24.5, 24.6, 24.7, 24.8, &24.9 are located in Table 19, 20, 21, 22, 23, 24, 25, 26 & 27.

Table 19. Unit 24.1 Objectives and Prescription

Unit # 24.1	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir dominance, increase gappiness (structural complexity) in homogeneous stands, maintain tree growth, increase structural heterogeneity, maintain amhibian corridor and meadows outside of unit.	
General	? Locate and flag skips and gaps as indicated on map. ? Fall all trees away from natural openings, meadows, created gaps, and skips	
Skips	? Install one 1/10th acre skip (74' diameter) ? Install one 1/5th acre skip (105' diameter) ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	0.1 0.2
Gaps	? Install one 1/10th acre gaps (74' diameter) ? Install one 1/5th acre gaps (105' diameter) ? Flag all gaps with orange flagging ? All gaps must be located in forested areas, not in existing natural gaps ? Cut all trees in gaps, except hardwoods, cedar, or western white pine	0.1 0.2
Spacing	? Thin remaining unit to 15'x15' spacing (194 tpa) ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, alaska yellow cedar or hardwoods and ignore for spacing ? Cut no trees 9" or greater dbh; ignore these trees for spacing purposes. ? Girdle trees 7"-9" dbh; cut trees that are less than 7" dbh to meet spacing requirement. Where possible choose these larger trees as the leave trees	5 acres

Table 20. Unit 24.2 Objectives and Prescription

Unit # 24.2	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir dominance, increase gappiness in homogeneous stands, maintain tree growth, increase structural heterogeneity, maintain amphibian corridor and meadows outside of unit, improve habitat along old-growth forest edge.	
General	? Locate and flag skips and gaps as indicated on map. Note that some skips and gaps are adjacent to each other. ? Fall all trees away from natural openings, meadows, created gaps, skips and streams	
Skips	? Install eight 1/5th acre skips (105' diameter) ? Install a 50' wide stream skip in the area located on the map ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	1.6 0.4
Gaps	? Install seventeen 1/10th acre gaps (74' diameter) ? Flag all gaps with orange flagging ? All gaps must be located in forested areas, not in existing natural gaps ? Cut all trees in gaps, except hardwoods, cedar, or western white pine	1.7
Slash	? Lop slash in the 18'x18' spacing area by the old-growth forest so that the thinning slash is in contact with the forest floor; lopping includes removing branches and bucking the tree boles	2 acres
Spacing	? Thin the northern 150' of the unit that is adjacent to older forest edge to 18'x18' spacing (134 tpa) ? Thin remaining unit to 15'x15' spacing (194 tpa) ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing ? Cut no trees 9" or greater dbh; ignore these trees for spacing purposes. ? Girdle trees 7"-9" dbh; cut trees that are less than 7" dbh to meet spacing requirement. Where possible choose these larger trees as the leave trees	33 acres

Table 21. Unit 24.3 Objectives and Prescription

Unit # 24.3	Prescription/Contract Requirements	Acres

Objective	? Reduce silver fir dominance, increase gappiness in homogeneous stands, maintain tree growth, increase structural heterogeneity, protect headwater stream on east side of unit, protect current amphibian habitat along east side of stream (western part of unit)	
General	? Locate and flag skips and gaps as indicated on map. Note that some skips and gaps are adjacent to each other. ? Fall all trees away from natural openings, meadows, created gaps, skips and streams	
Skips	? Install ten 1/10th acre skips (74' diameter) ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	1
Gaps	? Install ten 1/10th acre gaps (74' diameter) ? Flag all gaps with orange flagging ? All gaps must be located in forested areas, not in existing natural gaps ? Cut all trees in gaps, except hardwoods, cedar, or western white pine	1
Spacing	? Thin remaining unit to 18'x18' spacing (134 tpa), cutting trees less than 7" dbh ? Girdle trees that are 7" -10" dbh to meet the spacing requirement. Where possible choose these larger trees as the leave trees ? Cut no trees 10" dbh or greater; ignore these larger trees for spacing purposes ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing	13 acres

Table 22. Unit 24.4 Objectives and Prescription

Unit # 24.4	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir and western hemlock dominance, maintain tree growth, increase structural heterogeneity	
General	? Fall all trees away from natural openings, meadows or created gaps	
Skips	? No skips in this unit	
Gaps	? No gaps in this unit	

Spacing	? Thin unit to 14'x14' spacing (222 tpa) ? Girdle trees that are 7" -10" dbh to meet the spacing requirement. Where possible choose these larger trees as the leave trees ? Cut no trees 10" dbh or greater; ignore these larger trees for spacing purposes ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, alaska yellow cedar or hardwoods and ignore for spacing	3 acres

Table 23. Unit 24.5 Objectives and Prescription

Unit # 24.5	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir dominance, increase gappiness in homogeneous stands, maintain tree growth, increase structural heterogeneity	
General	? Fall all trees away from natural openings, meadows, skips and created gap ? Locate and flag skips and gap as indicated on map. Note that some skips and gaps are adjacent to each other.	
Skips	? Install two 1/10th acre skips (74' diameter) ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	0.2
Gaps	? Install one 1/5th acre gaps (105' diameter) ? Flag gap with orange flagging ? Gap must be located in forested areas, not in existing natural gaps ? Cut all trees in gap, except hardwoods, cedar, or western white pine	0.2
Spacing	? Thin unit to 12'x12' spacing (302 tpa) ? Do not cut trees larger than 7" dbh; ignore for spacing purposes ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing	4 acres

Table 24. Unit 24.6 Objectives and Prescription

Unit # 24.6	Prescription/Contract Requirements	Acres

Objective	? Reduce silver fir dominance, increase gappiness in homogeneous stands, maintain tree growth, increase structural heterogeneity, protect riparian habitat for amphibians	
General	? Fall all trees away from natural openings, meadows, skips and created gap ? Locate and flag skips and gaps as indicated on map.	
Skips	? Install four 1/10th acre skips (74' diameter) ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	0.4
Gaps	? Install one 1/10th acre gap (74' diameter) ? Flag gap with orange flagging ? Gap must be located in forested areas, not in existing natural gaps ? Cut all trees in gaps, except hardwoods, cedar, or western white pine	0.1
Spacing	? Thin remaining unit to 12'x12' spacing (302 tpa), cutting trees less than 7" dbh ? Girdle trees that are 7" -10" dbh to meet the spacing requirement. Where possible choose these larger trees as the leave trees ? Cut no trees 10" dbh or greater; ignore these larger trees for spacing purposes ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing	9 acres

Table 25. Unit 24.7 Objectives and Prescription

Unit # 24.7	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir and western hemlock dominance, maintain tree growth, increase structural heterogeneity	
General	? Fall all trees away from natural openings or meadows	
Skips	? No skips in this unit	
Gaps	? No gaps in this unit	

Spacing	? Thin unit to 12'x12' spacing (302 tpa) ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, alaska yellow cedar or hardwoods and ignore for spacing	2 acres

Table 26. Unit 24.8 Objectives and Prescription

Unit # 24.8	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir dominance, increase gappiness (structural complexity) in homogeneous stands, improve forest habitat along meadow edge, improve habitat along old-growth forest edge. Increase snow accumulation and retention adjacent to wet meadows to help maintain meadow hydrology and habitat characteristics	
General	? Locate and flag gaps as indicated on map ? Fall all trees away from natural openings, meadows, created gaps, and old forest edge	
Skips	? No skips in this unit	
Gaps	? Install fifty-two 30' diameter gaps, approximate locations on map ? Flag all gaps with orange flagging ? All gaps must be located in forested areas, not in existing natural gaps ? Cut all trees in gaps, except hardwoods, cedar, or western white pine	0.8
Slash	? Lop slash in the 18'x18' spacing area (134 tpa) by the old-growth forest so that the thinning slash is in contact with the forest floor; lopping includes removing branches and bucking the tree boles	3 acres
Spacing	? Cut all silver fir trees that are within 100' of meadow edge and are smaller than 5" dbh. Fell all these trees away from the meadow. ? Thin the southern 150' of the unit that is adjacent to the older forest edge to 18'x18' (134 tpa) ? Thin remaining unit to 12'x12' spacing (302 tpa) ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing	22 acres

Table 27. Unit 24.9 Objectives and Prescription

Unit # 24.9	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir dominance, increase gappiness in homogeneous stands, increase structural heterogeneity, maintain meadow characteristics, protect and improve habitat for amphibians along meadow and streams. Explore the effectiveness of a size prescription in creating structural complexity.	
General	? Locate and flag skips and gap as indicated on map. Note that some skips and gaps are adjacent to each other. ? Fall all trees away from natural openings, meadows, streams, skips, and created gaps	
Skips	? Install five 1/5th acre skips (105' diameter) ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	1
Gaps	? install one large treed gap located along older forest edge, space gap trees 20x20 (109 tpa), leaving only the largest trees ? cut no trees 10" or greater dbh; ignore for spacing purposes ? girdle trees between 7" -10" dbh that do not meet the 20x20 large gap spacing requirement	
Spacing	? cut silver fir trees that are smaller than 5" dbh ? Leave all other tree species	15 acres

Post Treatment

Unit 24.1

Initially the five acre Unit 24.1 was part of the larger thirty-three acre Unit 24.2; however in the prescription development process an opportunity to provide an undisturbed connection between a wetland associated with a stream and the older forest edge created a separation between these two units. There are variations between the prescriptions of these two units (24.1 and 24.2) although the tree spacing remains the same (194 trees per acre). The eastern boundary of Unit 24.1 was defined by topographical limitations. More specifically, the area adjacent to and west of the 230.1 road is steep with minimal trees. Post treatment data for Unit 24.1 is provided in Table 28. Two gaps and a skip occur in unit 24.1 with their approximate locations indicated on the map of Unit 24 is located in Appendix A.

Table 28. Unit 24.1 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	220
silver fir, 2 - 8"dbh	170
Noble fir, 5 - 8" dbh	50

*sample information: five plots were measured.

Unit 24.2
As indicated above, Unit 24.1 and Unit 24.2 were initially identified as one unit. An attempt at softening the edge between the older forest and the younger forest (Unit 24.2) is experimented with in the prescriptions for Unit 24.2. The edge softening prescriptions calls for a 150 foot band of wider spacing (134 tpa) adjacent to the older forest edge. The vision is that a wider spacing allows these thinned trees to develop differently over time. These trees that are thinned fairly widely may develop with more dominant tree characteristics over time while the rest of unit 24.2 (194 trees per acre) may develop trees with more co-dominant characteristics. The thinning slash in the wider spaced band was required to be lopped as well. Lopping thinning slash in this area may allow for easier travel along the older forest edge by wildlife and may reduce the short term fire hazard in this area. Additionally, skips and gaps are scattered throughout Unit 24.2. Along the western boundary, two circular skips connected by a linear skip is prescribed to provide undisturbed amphibian habitat and travel opportunities. A map of unit 24 is located in Appendix A.

Unit 24.3
The restoration thinning project team identified areas to the north and to the west and adjacent to unit 24.3 boundaries to be left untreated, essentially skips. The untreated area to the west was identified as a leave area because it appeared to have larger trees and more diversity in canopy development. The untreated area to the north was identified as a leave area because of the presence of a wetland associated with a stream. While the thinning prescription for unit 24.3 is 134 trees per acre, a greater number of trees is anticipated to be left because the thinning prescription also requires all trees that are 10" and greater to be left and ignored for spacing purposes. Additionally the prescription calls for ten $1/10^{th}$ acre gaps and ten $1/10^{th}$ acre skips to be located throughout unit 24.3. A map of Unit 24 is located in Appendix A.

Unit 24.4
Unit 24.4 is a narrow, small area (3 acres) that is impacted by a road occurring on almost all of the unit's boundaries except the southern boundary. To provide variability between the spacing prescriptions of Unit 24, the project team decided on a prescription of 222 trees per acre for Unit 24.2. Post treatment data for Unit 24.2 is provided in Table 29 and a map of Unit 24 is located in Appendix A.

Table 29. Unit 24.4 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	233
silver fir, 6 - 14"dbh	233

*sample information: three plots were measured.

Unit 24.5
Unit 24.5 is a small area (4 acres) that, like Unit 24.2, is impacted by a road occurring on almost all of the unit's boundaries, except the western boundary. A small surface rock pit is located adjacent to this Units boundaries, at the junction of the 213.5A and 213.5 road. The spacing prescription in this unit is 302 trees per acre. One $1/5^{th}$ acre gap and two $1/10^{th}$ acre skips are part of the prescription as well. A map of Unit 24.5 is located in Appendix A.

Unit 24.6
Unit 24.6 is a slightly larger unit (9 acres) than units 24.4 and 24.5. This unit has forest roads located on two sides and both rocky areas and wet meadows occurring along it's edges. Due to the natural gappiness along the edges, only one additional gap was included in the prescription along with four skips. The spacing prescription for this units is 302 trees per acre. A map of Unit 24.6 is located in Appendix A.

Unit 24.7
Unit 24.7 is small (2 acres) and located adjacent to the CRW hydrographic boundary. Due to this Unit's small size and geographic features surrounding the unit (shrub, rock and road) no gaps or skips were included in the prescription. The unit was thinned to 302 trees per acre. A map of Unit 24.7 is located in Appendix A.

Unit 24.8

Unit 24.8 surrounds a riparian related forested wetland complex. With the intention of extending the water filtration period into and through this wetland complex in the spring, many small, closely spaced gaps were installed. The vision is that these small gaps will allow a greater amount of snow to come in contact with the forest floor and accumulate in greater quantities than in the surrounding thinned and unthinned areas. This increased amount of snow may melt slower and over a longer period of time during the spring and early summer thus percolating water through the forested wetland and wet meadow complex over a longer period of time.

The variable thinning along the wet meadow edge was prescribed to enhance amphibian habitat. The diameter limit restriction should allow larger neighbor trees to be untouched while small densely growing trees and small suppressed trees are eliminatedt. The band of wider spacing along the older forest edge is intended to soften the appearance of an edge between the younger forest and the older forest, similar to Unit 24.2. A relatively wide spacing (134 trees per acre) in this band should provide opportunities for the leave trees to use available resources to increase in diameters and maintain full canopies into the future. Lopping slash along this older forest edge may minimize impacts of thinning slash to wildlife movement. Post treatment data for Unit 24.8 is provided in Table 30 and a map of Unit 24 is located in Appendix A.

Table 30. Unit 24.8 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	290
silver fir, 2 - 5"dbh	260
Noble fir, 5 – 6" dbh	20
Western hemlock, 3" dbh	10

*sample information: five plots were measured.

Unit 24.9

Unit 24.9 is composed of a forest of larger diameter, taller trees, yet still appropriate for restoration consiseration. To respect the community establishment of these trees and to promote tree growth the project team developed a diameter based thinning prescription. The contract thinners were required to cut all silver fir trees that were smaller than 5" dbh. This prescription allows larger trees (>5" dbh) that are growing close to one another to remain unthinned. It is not uncommon in young silver fir forests to find the co-dominant trees growing close to one another for unknown reasons and this spacing prescription attempts to respect that.

Five skips and one treed gap were included in the prescription for this unit. The treed gap was intended to have 109 leave trees per acre; however after treatment, the leave trees remaining were about a quarter of that. While the thinning contractors left fewer trees than prescribed, the treed gap did meet the intended objective. The intention of the placement (adjacent to the older forest and in an area of natural gappiness) and objective for this gap was to prolong the gap appearance (and perhaps function) in the near term. The excessive cutting by the contract thinners, in this gap should meet the intention.

A diameter limit prescription does not lend itself to summary tables well; however post treatment data for Unit 24.9 is provided in Table 31 and a map of Unit 24 is located in Appendix A.

Table 31. Unit 24.9 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	288
silver fir, 5 - 10"dbh	238
Western hemlock, 2 - 7" dbh	50

*sample information: four plots were measured.

<u>Unit 36.1, 36.2, 36.3, 36.4 (50 acres)</u>

Location: Upper Watershed

Unit History and Context

Units 36.1, 36.2, 36.3 & 36.4 (Unit 36) are located in the North Fork Cedar River basin. Approximately one mile downstream from Unit 36 the North Fork Cedar River and the South Fork Cedar River join to

form the upper Cedar River. The upper Cedar River flows into Chester Morse Lake. Records indicate that the area that comprises Unit 36 was clear-cut harvested between the years of 1952 and 1979, a twenty seven year period; however the trees that were thinned in Unit 36 seem closer in age. There is a mix of species, including Douglas-fir in this unit and it is unclear whether or not this area was allowed to regenerate naturally. Table 32 provides pre-treatment summary data. Original forest (old growth) borders unit 36 to the south. Additionally, talus slopes are scattered between the units. A mid-slope road (523 Road) bi-sects Unit 36 and is scheduled to be decommissioned.

An operational restriction, because of northern goshawk and marbled murrelet habitat nearby, required restoration thinning to begin after August 31. The noise from chainsaw operations should not disturb any nesting activities if begun after August 31. Pre-treatment data for this area was collecting in 2006 and is summarized in Table 32.

Table 32. Unit 36 2006 pre-treatment summary data

Type	Average number of trees per acre
Total number of trees	6,500
Western hemlock, 0 – 1.6" dbh	4,500
Silver fir, 0 - 2" dbh	1,167
Douglas-fir, 0 - 2" dbh	833

*sample information: three plots were measured.

Unit 36.1 is 8 acres; Unit 36,2 is 25 acres; Unit 36.3 is 15 acres and Unit 36.4 is 4 acres. A map of these units is located in Appendix A. Prescriptions for Unit 36 are provided in the following Table33, 34,35 &Table 36.

Table 33. Unit 36.1 Objectives and Prescription

Unit # 36.1	Prescription/Contract Requirements	Acres
Objective	? Reduce dominance of silver fir and western hemlock, maintain hardwoods, increase spatial heterogeneity, encourage shrub growth to stabilize summer temperatures, avoid impacts to marbled murrelets and goshawks, promote habitat for larch mountain salamander and other amphibians.	
General	? Locate and flag skips and gaps as indicated on map. Note that some skips and gaps are adjacent to each other. ? Fall all trees away from natural openings, meadows, created gaps, skips and streams	
Skips	? Install one 1/10th acre skip (74' diameter) ? Install one 1/5th acre skip (105' diameter) ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	0.1 0.2
Gaps	? Install six 1/10th acre gaps (74' diameter) ? Install one 1/5th acre gap (105' diameter) ? Flag all gaps with orange flagging ? All gaps must be located in forested areas, not in existing natural gaps ? Cut all trees in gaps, except western white pine, cedar, or hardwoods	0.6 0.2

Spacing	? Leave all tree that are 6" dbh or greater in areas outside of the gaps, ignore for spacing purposes ? Thin the remaining unit to 15'x15' spacing (194 tpa) ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, alaska yellow cedar or hardwoods and ignore for spacing purposes	8 acres

Table 34. Unit 36.2 Objectives and Prescription

Unit # 36.2	Prescription/Contract Requirements	Acres
Objective	? Reduce dominance of silver fir and western hemlock, maintain hardwoods, increase spatial heterogeneity, encourage shrub growth to stabilize summer temperatures, avoid impacts to marbled murrelets and goshawks, promote habitat for larch mountain salamander and other amphibians. Provide shaded habitat connectivity between old-growth and streams.	
General	? Locate and flag skips and gaps as indicated on map. Note that some skips and gaps are adjacent to each other. ? Fall all trees away from natural openings, meadows, created gaps, skips and streams	
Skips	? Install two 1/10th acre skips (74' diameter) ? Install two 1/5th acre skips (105' diameter) ? Install one 1 acre skip (235' diameter) partially in Unit 36.3 ? Install two 50' wide stream skips in areas located on the map (stream location already flagged in pink) ? Flag all circular skips with blue flagging ? Cut no trees in skip areas identified on map	0.2 0.4 0.5 1.3
Gaps	? Install ten 1/10th acre gaps (74' diameter) ? Install three 1/5th acre gaps (105' diameter) ? Flag all gaps with orange flagging ? All gaps must be located in forested areas, not in existing natural gaps ? Cut all trees in gaps, except western white pine, cedar, or hardwoods	1 0.6
Spacing	? Leave all tree that are 6" dbh or greater in areas outside of the gaps ? Thin the remaining unit to 14'x14' spacing (222 tpa) ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, alaska yellow cedar or hardwoods and ignore for spacing	

		25 acres

Table 35. Unit 36.3 Objectives and Prescription

Unit # 36.3	Prescription/Contract Requirements	Acres
Objective	? Reduce dominance of silver fir and western hemlock, maintain hardwoods, increase spatial heterogeneity, encourage shrub growth to stabilize summer temperatures, avoid impacts to marbled murrelets and goshawks, promote habitat for larch mountain salamander and other amphibians. Provide shaded habitat connectivity between old-growth and streams.	
General	? Locate and flag skips and gaps as indicated on map. Note that some skips and gaps are adjacent to each other. ? Fall all trees away from natural openings, meadows, created gaps, skips and streams	
Skips	? Install one 1/10th acre skip (74' diameter) ? Install two 1/5th acre skips (105' diameter) ? Install one 1 acre skip (235' diameter) partially in Unit 36.2 ? Install two 50' wide stream skips in areas located on the map (stream location already flagged in pink) ? Flag all circular skips with blue flagging ? Cut no trees in skip areas identified on map	0.1 0.4 0.5
Gaps	? Install four 1/10th acre gaps (74' diameter) ? Install two 1/5th acre gaps (105' diameter) ? Flag all gaps with orange flagging ? All gaps must be located in forested areas, not in existing natural gaps ? Cut all trees in gaps, except western white pine, cedar, or hardwoods	0.4 0.4
Spacing	? Leave all tree that are 6" dbh or greater in areas outside of the gaps ? Thin the remaining unit to 18'x18' spacing (134 tpa) ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing	15 acres

Table 36. Unit 36.4 Objectives and Prescription

Unit # 36.4	Prescription/Contract Requirements	Acres

Objective	? Reduce dominance of silver fir and western hemlock, maintain hardwoods, increase spatial heterogeneity, encourage shrub growth to stabilize summer temperatures, avoid impacts to marbled murrelets and goshawks, promote habitat for larch mountain salamander and other amphibians. Provide shaded habitat connectivity between talus slopes.	
General	? Locate and flag skips as indicated on map ? Fall all trees away from natural openings and skips	
Skips	? Install two 50' wide linear skips in areas indicated on the map ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	0.3
Gaps	? no gaps in this unit	
Spacing	? Leave all tree that are 6" dbh or greater in thinned areas ? Thin the remaining unit to 16'x16' spacing (170 tpa) ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing purposes	2 acres

Post Treatment

Unit 36.1

Unit 36.1 was a densely stocked developing forest with a road bordering it to the north, older forest bordering it to the south, a talus slope bordering it to the west and the same type of younger forest bordering it to the east. While not a part of this unit, a skip was designed adjacent to the stream to the east to minimize thinning impacts to inner gorge stream related topography. This skip will also provide undisturbed habitat for resident amphibians. The prescription for Unit 36.1 calls for 194 trees per acre. At this density, Unit 36.1 should develop into forest with trees exhibiting co-dominant crown characteristics. The post-treatment indicates a closer spaced tree distribution (283 trees per acre) which can be attributed to the diameter limit prescription. The six gaps included in this prescription will allow for diversity in crown development along the gap edge, and potentially allow for a small amount of diversity in the understory plant community. Two skips are included in this unit as well.

It is unknown whether or not Larch Mountain salamanders reside in the talus slope on this hillside (Larch Mountain salamander is a Federal Species of Concern and a Washington State sensitive species); however this salamander is found in habitat with similar features. Varying the tree spacing between the units that comprise Unit 36, and providing skips within these units is intended to provide short term (skip) and long term (trees maturing towards older forest characteristics) habitat for the salamanders and other less sensitive species.

Post treatment data for Unit 36.1 is provided in Table 37 and a map of Unit 36 is located in Appendix A.

Table 37. Unit 36.1 2008 post-treatment information

Type	Average number of trees per acre

Total number of trees	283
silver fir, 1 - 3"dbh	100
Western hemlock, 1 - 4" dbh	50
Douglas-fir, 4 – 10" dbh	33
Noble fir, 2 -4" dbh	33
Western red cedar, 2 – 3" dbh	67

*sample information: three plots were measured.

Unit 36.2

Unit 362 was a densely stocked developing forest with a road bordering it to the north, older forest bordering it to the south, and a talus slope bordering it to the east and west. A linear skip was designed through Unit 36.2 and Unit 36.3. This skip was located in what appeared to be a small linear depression on the LiDAR ground data. This depression was not easily detected in the field. A small area near the old growth edge did have devils club and other wet indicator plants; however the remaining area appeared dry with no obvious vegetation indicating otherwise. The prescription for Unit 36.2 calls for 222 trees per acre. The prescription also calls for ten $1/10^{th}$ acre gaps and three $1/5^{th}$ acre gaps as well as two $1/10^{th}$ acre skips, two $1/5^{th}$ acre skips, the linear skip and an acre skip shared with Unit 36.3, directly to the north. Larch Mountain Salamander habitat was a consideration in the spacing and skip prescription for this unit (see Unit 36.1 previous). A map of Unit 36 is located in Appendix A.

Unit 36.3

Unit 36.3 was a densely stocked developing forest with a road bordering it to the south, slightly older dense forest bordering it to the north, talus slope bordering it to the west and a developing mixed conifer and hardwood forest bordering it to the east. The developing forest in Unit 36.3 and Unit 36.2 are very similar. As you move up slope towards the old growth forest the trees get smaller in diameter and height and as you move down slope toward the North Fork of the Cedar River the trees increase in diameter and height. The pre-treatment tree density and tree size made it difficult in many places to navigate through the forest. The prescription for Unit 36.3 required the widest spacing for all the units that make up Unit 36, at 134 trees per acre. The project team sought tree spacing variability, which is why there are four units and why these four units have different spacing prescriptions. The widest spacing in unit 36.3 seemed most appropriate because the trees in Unit 36.3 appeared a little further along in their development trajectory and ideally could respond to a wider spacing (more growing room, less competition for available resources) sooner.

The prescription in Unit 36.3 also required two $1/5^{th}$ acre gaps, two $1/5^{th}$ acre skips, one $1/10^{th}$ acre skip and part of one 1 acre skip shared with Unit 36.2. The linear skips, begun at the older forest edge to the south were continued through Unit 36.3. The linear skip may provide connectivity opportunities for amphibians and other sensitive wildlife. Similarly to Unit 36.2, this linear skip was located in what appeared to be a small linear depression on the LiDAR ground data; however, there was no obvious depression and no physical evidence of water movement in this area. Post treatement data for Unit 36.3 is located in Table 38, and a map of Unit 36 is located in Appendix A.

Table 38. Unit 36.3 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	150
silver fir, 4 - 9"dbh	67
Western hemlock, 5" dbh	50
Douglas-fir, 7 – 9" dbh	33
Noble fir, 6 - 7" dbh	33

*sample information: three plots were measured.

Unit 36.4

Unit 36.4 is a two acre unit, bisected by a forest road (523 road) and flanked by talus slope. Two linear skips are prescribed for the purpose of providing undisturbed connectivity between the talus slopes. The Larch Mountain Salamander was the consideration for prescribing these skips. The spacing prescription for Unit 36.4 is 170 trees per acre. A map of Unit 36 is located in Appendix A.

Unit 61.1A, 61.1B, 61.1C, 61.2, 61.3, 61.4A, 61.4B, 61.4C, 61.5, 61.6, 61.7, 61.8, 61.8A, 61.8B, 61.8C, 61.8D, 61.8E, 61.9, 61.10, 61.11, 61.12 (393 acres)

Location: Upper Watershed

Unit History and Context

Units 61.1A, 61.1B, 61.1C, 61.2, 61.3, 61.4A, 61.4B, 61.4C, 61.5, 61.6, 61.7, 61.8, 61.8A, 61.8B, 61.8C, 61.8D, 61.8E, 61.9, 61.10, 61.11 & 61.12 (Unit 61) are located in the upper Lindsay Creek Basin, and like Units 18 and 24, include the headwaters of several tributaries to Lindsay Creek. Lindsay Creek flows into the Rex River. Records indicate that the area that comprises Unit 61 was harvested between the years of 1969 and 1973, a four year period. Currently, this large area is dominated by silver fir which regenerates readily easily naturally; it is therefore assumed that this area was allowed to regenerate naturally after harvest. An operational restriction, because of potential marbled murrelet nesting habitat nearby, required restoration thinning to begin after August 31. The noise from chainsaw operations should not disturb any nesting activities if begun after August 31. Tables 39,40 and 41 provide pre-treatment summary data. Original forest (old growth) borders several of the southerly located units, and original forest is located near by (over the ridge in the next basin to the east).

There were frequent bear sightings in this area and a large percentage of the Douglas-fir had extensive bear damage.

Table 39. Unit 61 2006 pre-treatment summary data for Units 61.6 & 61.7

Type	Average number of trees per acre
Total number of trees	4,093
Western hemlock, 0 – 8" dbh	1,250
Silver fir, 0 - 3" dbh	2,611
Douglas-fir, 7" dbh	56
Mountain hemlock, 1" dbh	111
Noble fir, 7" dbh	56

*sample information: nine plots were measured.

Table 40. Unit 61 2006 pre-treatment summary data for Units 61.4A, 61.4B & 61.4C

Type	Average number of trees per acre
Total number of trees	4,060
Western hemlock, 1-2" dbh	120
Silver fir, 1 - 5" dbh	3,760
Douglas-fir, 8" dbh	60
Western red cedar, 3" dbh	20
Noble fir, 9-14" dbh	100

*sample information: five plots were measured.

Table 41. Unit 61 2006 pre-treatment summary data for Units 61.9 & 61.10

Type	Average number of trees per acre
Total number of trees	7,417
Western hemlock, 2-3" dbh	875
Silver fir, 1 - 2" dbh	6,750
Noble fir, 5" dbh	83

*sample information: three plots were measured.

Acreage information about Unit 61's sub-units is provided in Table 42. A map of these units is located in Appendix A. Prescriptions for Unit 61are provided in the following Table 43,44.45,46,47,48,49,50,51,52,53,54,55,56,57, &58.

Table 42. Unit 61 acres by sub-unit

Unit #	Acres
61.1A	8
61.1B	35
61.1C	23

61.2	23
61.3	3
61.4A	28
61.4B	2
61.4C	4
61.5	30
61.6	33 (leave)
61.7	13
61.8	78
61.1A thru 61.8E	17
61.9	15
61.10	11
61.11	56
61.12	14

Table 43. Unit 61.A Objectives and Prescription

Unit # 61.1a	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir and western hemlock dominance, maintain tree growth, increase structural heterogeneity. Explore the effectiveness of a size prescription in creating structural complexity.	
General	? Fall all trees away from natural openings, meadows, and streams	
Spacing	? Cut all trees that are smaller than 7"dbh ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, alaska yellow cedar or hardwoods and ignore for spacing	8 acres

Table 44. Unit 61.B Objectives and Prescription

Unit # 61.1b	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir dominance, increase gappiness in homogeneous stands, maintain tree growth. Provide short-term shade for amphibian habitat along streams, accelerate forest development over the long term for amphibian habitat along streams.	
General	? Locate and flag skips and gaps as indicated on map. Note that some skips and gaps are adjacent to each other. ? Fall all trees away from natural openings, meadows, streams, skips and created gaps	
Skips	? Install five 0.4 acre skips (150' diameter) ? Locate and flag 100' wide stream skip, located on alternating sides	2 4.3

	of stream. ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	
Gaps	? Install fourteen 30' diameter gaps per acre ? Install gaps 55 feet apart on a square grid ? Flag all gaps with orange flagging ? Do not cut hardwoods, western redcedar, western white pine, or alaska yellow cedar in the gaps ? Cut no trees that are 8" dbh and larger in the gaps	8
Spacing	? Thin unit (area between the gaps) to 12'x12' spacing (302 trees per acre) ? Cut no trees that are 8" dbh and larger ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, alaska yellow cedar or hardwoods and ignore for spacing	35 acres

Table 45. Unit 61.C Objectives and Prescription

Unit # 61.1c	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir and western hemlock dominance, maintain tree growth, increase structural heterogeneity. Provide short-term shade for amphibian habitat along streams, accelerate forest development over the long term for amphibian habitat along streams. Explore the effectiveness of a size prescription in creating structural complexity.	
General	? Fall all trees away from natural openings, meadows, and streams	
Skips	? Locate and flag 100' wide stream skip on south side of stream on north end of unit	2
Gaps	? No gaps in this unit	
Spacing	? Cut all silver fir that are smaller than 5" dbh ? Cut all western hemlock that are smaller than 3" ? Leave all other tree species	23 acres

Table 46. Unit 61.2 Objectives and Prescription

Unit # 61.2	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir and western hemlock dominance, increase gappiness (structural complexity) in homogeneous stands, maintain tree growth, increase structural heterogeneity	
General	? Locate and flag skips and gaps as indicated on map. Note that some skips and gaps are adjacent to each other. ? Fall all trees away from natural openings, meadows, skips and created gaps	
Skips	? Install six 1/5th acre skips (105' diameter) ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	1.2
Gaps	? Install six 1/5th acre gaps (105' diameter) ? Flag all gaps with orange flagging ? All gaps must be located in forested areas, not in existing natural gaps ? Two gaps will be occupied by one standing tree (all others cut); ? Two gaps will be occupied by two trees (all others cut); ? Two gaps will be occupied by three trees (all others cut); ? The gap 'leave' trees will be located near the center of the gap ? If any species other than silver fir or western hemlock are present, leave them as the gap leave trees. Otherwise, leave the best available western hemlock or silver fir	1.2
Spacing	? Thin remaining unit to 15'x15' spacing (194 tpa) ? Leave all trees greater than 10" dbh; ignore these trees for spacing purposes ? when necessary, girdle trees that are 7" -10" dbh to meet spacing requirement ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, alaska yellow cedar or hardwoods and ignore for spacing	23 acres

Table 47. Unit 61.3 Objectives and Prescription

Unit # 61.3	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir and western hemlock dominance, maintain tree growth, increase structural heterogeneity. Explore the effectiveness of a size prescription in creating structural complexity.	

Spacing	? Cut all trees that are smaller than 8" dbh ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing	
Slash	? lop thinning slash so that the thinning slash is in contact with the forest floor; lopping includes removing branches and bucking the tree boles	3 acres

Table 48. Unit 61.4A Objectives and Prescription

Unit # 61.4a	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir and western hemlock dominance, increase gappiness in homogeneous stands, maintain tree growth, increase structural heterogeneity	
General	? Locate and flag skips and gaps as indicated on map. Note that some skips and gaps are adjacent to each other. ? Fall all trees away from natural openings, meadows, skips and created gaps	
Skips	? Install five 1/10th acre skips (74' diameter) ? Install five 1/5th acre skips (105' diameter) ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	0.5 1
Gaps	? Install five 1/10th acre gaps (74' diameter) ? Install five 1/5th acre gaps (105' diameter) ? Flag all gaps with orange flagging ? All gaps must be located in forested areas, not in existing natural gaps ? In 1/10th acre gaps, cut all trees ? In 1/5th acre gaps, cut all silver fir and western hemlock trees, ignore other species	0.5 1
Spacing	? Thin remaining unit to 18'x18' spacing (134 tpa) ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing	28 acres

Table 49. Unit 61.4B Objectives and Prescription

Unit # 61.4b	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir and western hemlock dominance, maintain tree growth, increase structural heterogeneity. Explore the effectiveness of a size prescription in creating structural complexity.	
Spacing	? Cut all trees that are smaller than 8" dbh ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing ? Fall all trees away from natural openings	
Slash	? lop thinning slash so that the thinning slash is in contact with the forest floor; lopping includes removing branches and bucking the tree boles	2 acres

Table 50. Unit 61.4C Objectives and Prescription

Unit # 61.4c	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir and western hemlock dominance, maintain tree growth, increase structural heterogeneity. Explore the effectiveness of a size prescription in creating structural complexity.	
Spacing	? Cut all trees that are smaller than 8" dbh ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing ? Fall all trees away from natural openings, meadows or created gaps	
Slash	? lop thinning slash so that the thinning slash is in contact with the forest floor; lopping includes removing branches and bucking the tree boles	4 acres

Table 51. Unit 61.5 Objectives and Prescription

Unit # 61.5	Prescription/Contract Requirements	Acres

Objective	? Reduce silver fir dominance, increase gappiness (structural complexity) in homogeneous stands, maintain tree growth. Provide short-term shade for amphibian habitat along streams, accelerate forest development over the long term for amphibian habitat along streams. Provide habitat connectivity between old forest and wet meadows.	
General	? Locate and flag skips and gaps as indicated on map. Note that some skips and gaps are adjacent to each other. ? Fall all trees away from natural openings, meadows, streams, skips and created gaps	
Skips	? Install fifteen 1/10th acre skips (74' diameter) ? Install a 100' wide stream skip located on west side of stream, as shown on map ? Install a 150' wide skip connecting older forest and unit 61.6, as shown on map ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	1.5 1 3.4
Gaps	? Install twelve 1/10th acre gaps (74' diameter) as shown on map ? Flag all gaps with orange flagging ? All gaps must be located in forested areas, not in existing natural gaps ? cut all trees in gaps	1.2
Spacing	? Thin unit between the linear skips to 15'x15' spacing +/- 10' with 33% of the trees spaced 5'x5' (1740 tpa), 33% of the trees spaced 15'x15' (194 tpa) and 33% of the trees spaced 25'x25' (70 tpa), spacing should vary fro m tree to tree ? Thin remaining unit to the east and west of the linear skips to 15'x15' spacing (194 tpa) ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, alaska yellow cedar or hardwoods and ignore for spacing	30 acres

Table 52. Unit 61.7 Objectives and Prescription

Unit # 61.7	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir dominance, increase gappin ess (structural complexity) in homogeneous stands, maintain tree growth, provide short-term and long-term amphibian habitat	

General	? Locate and flag skip as indicated on map ? Fall all trees away from natural openings, meadows, skip and created gaps	
Skips	? Locate and flag meadow area skip as shown on map ? Flag skip with blue flagging ? Cut no trees in skip area identified on map	3.9
Gaps	? Install six 1/10th acre gaps (74' diameter) ? Flag all gaps with orange flagging ? All gaps must be located in forested areas, not in existing natural gaps ? cut all trees in gaps, except hardwoods, cedar, or western white pine	0.6
Spacing	? Thin remaining unit to 18'x18' spacing (134 trees per acre) ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing	13 acres

Table 53. Unit 61.8 Objectives and Prescription

Unit # 61.8	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir dominance, increase gappiness (structural complexity) in homogeneous stands, maintain tree growth. Provide short-term shade for amphibian habitat along streams, accelerate forest development over the long term for amphibian habitat along streams.	
General	? Locate and flag skips as indicated on map ? Fall all trees away from natural openings, meadows, streams and skips	
Skips	? Locate and flag 100' wide stream skip, located on map and encompassing the stream confluences ? Install nine 1/5th acre skips (105' diameter) ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	5 1.8
Gap/Snag patches	? Install seven 1/5th acre gaps (105' diameter) ? Within gaps, girdle all trees that are greater than 8" dbh and cut all trees smaller than 8" dbh.	1.4

	? Within each gap leave the one largest live tree near the center of the gap ? If any species other than silver fir or western hemlock are present, leave them as the gap leave tree, otherwise leave the best available western hemlock or silver fir	
Spacing	? Thin portion of the unit that lies west of the main stream to 16'x16' spacing (170 tpa) ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing ? No spacing prescription east of the main stream	78 acres

Table 54. Unit 61.8A thur 61.8E Objectives and Prescription

Unit # 61.8, A, B, C, D, E	Prescription/Contract Requirements	Acres
Objective	? Increase snow accumulation and retention adjacent to wet meadows to help maintain meadow hydrology and habitat characteristics	
General	? Locate and flag gaps as indicated on map ? Fall all trees away from natural openings, meadows or created gaps	
Gaps	? In each unit A-E, locate and flag eight rectangle shaped 35'x150' gaps oriented true east-west, locations indicated on unit map ? In each unit A-E, in the center of three of the rectangle gaps four trees will be left separated by 30' intervals, all other trees in gaps will be cut ? All trees not designated as leave trees in the gap and 8" dbh and greater will be girdled ? All trees less than 8" dbh, not designated as leave trees will be cut ? Flag all gaps with orange flagging ? All gaps must be located in forested areas, not in existing natural gaps	4.8
Spacing	? Between the rectangular gaps, space trees in snow retention subunits 8'x8' (680 tpa) ? Within the 8x8 spacing area, trees 8" dbh and larger may be girdled to meet spacing requirement	17 acres

NOTE: Subunit A = 4 ac, B = 3 ac, C = 3 ac, D = 3 ac, and E = 4 ac. Total = 17 acres

Table 55. Unit 61.9 Objectives and Prescription

Unit # 61.9	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir dominance, increase gappiness (structural complexity) in homogeneous stands, maintain tree growth, provide short-term and long-term amphibian habitat	
General	? Locate and flag skips and gaps as indicated on map. Note that some skips and gaps are adjacent to each other. ? Fall all trees away from natural openings, meadows, pond, skips and created gaps ? Includes one acre unit to the east of the 200.8 road	
Skips	? Locate and flag 100' wide linear skip area, location indicated on map ? Install four 1/10th acre skips (74' diameter) ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	1.1 0.4
Gaps	? Install four 1/10th acre gaps (74' diameter) ? Install two 1/5th acre gaps (105' diameter) ? Flag all gaps with orange flagging ? All gaps must be located in forested areas, not in existing natural gaps ? cut all trees in gaps, except hardwoods, cedar, or western white pine	0.4 0.4
Spacing	? Thin remaining unit south of the skip to 16'x16' spacing (170 trees per acre) ? Thin remaining unit north of the skip to 18'x18' spacing (134 trees per acre) ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, alaska yellow cedar or hardwoods and ignore for spacing	16 acres

Table 56. Unit 61.10 Objectives and Prescription

Unit # 61.10	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir dominance, increase gappiness (structural complexity) in homogeneous stands, maintain tree growth, provide short-term and long-term amphibian habitat	

General	? Locate and flag skips and gaps as indicated on map ? Fall all trees away from natural openings, meadows, skips and created gaps	
Skips	? Locate and flag 100' wide linear skip area, location indicated on map ? Install four 1/10th acre skips (74' diameter) ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	1.3 0.4
Gaps	? Install six 1/10th acre gaps (74' diameter) ? Flag all gaps with orange flagging ? All gaps must be located in forested areas, not in existing natural gaps ? cut all trees in gaps, except hardwoods, cedar, or western white pine	0.6
Spacing	? Thin remaining unit to 18'x18' spacing (134 tpa) ? All trees that do not meet the spacing requirement and are greater than 8" may be girdled ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, Alaska yellow cedar or hardwoods and ignore for spacing	11 acres

Table 57. Unit 61.11 Objectives and Prescription

Unit # 61.11	Prescription/Contract Requirements	Acres
Objective	? Increase gappiness in homogeneous stands, increase structural heterogeneity. Provide short-term small diameter snag habitat for snag-dependent species in close proximity to an old-growth stand.	
General	? Locate and flag gaps as indicated on map ? Fall all trees away from natural openings and meadows	
Skips	? Skip area on the western edge of the unit at the end of the 208.2 road, as indicated on map ? Cut no trees in skip area identified on map	3.7
Gap/Snag patches	? Install 27 1/10th acre gaps (74' diameter) ? Install nine 1/5th acre gaps (105' diameter)	2.7 1.8

	? Within gaps, girdle all trees that are greater than 8" dbh and cut all trees smaller than 8" dbh. ? Within each gap leave the one largest live tree near the center of the gap ? If any species other than silver fir or western hemlock are present, leave them as the gap leave tree, otherwise leave the best available western hemlock or silver fir	
Spacing	? No thinning in remaining unit	56 acres

Table 58. Unit 61.12 Objectives and Prescription

Unit # 61.12	Prescription/Contract Requirements	Acres
Objective	? Reduce silver fir dominance, increase gappiness in homogeneous stands, maintain tree growth, increase structural heterogeneity. Explore the effectiveness of a variable prescription in creating complexity on a tree to tree basis.	
General	? Locate and flag skips as indicated on map ? Fall all trees away from natural openings and skips	
Skips	? Install five 1/5th acre skips (105' diameter) ? Flag all skips with blue flagging ? Cut no trees in skip areas identified on map	1
Spacing	? Thin unit between the small skips to 15'x15' spacing +/- 5' with 33% of the trees spaced 10'x10' (435 tpa), 33% of the trees spaced 15'x15' (194 tpa) and 33% of the trees spaced 20'x20' (109 tpa), spacing should vary from tree to tree ? Leave tree priority shall be: (1) noble fir, (2) Douglas-fir, (3) western hemlock, (4) silver fir ? Cut no red cedar, western white pine, alaska yellow cedar or hardwoods and ignore for spacing	14 acres

Post Treatment

Unit 61.1A

Because of a difference in tree size, Unit 61.1A was identified as a separate unit from Unit 61.1B and 61.1C. The trees in Unit 61.1A appeared further along in development (size) and ideally would benefit from a unique prescription, a prescription that was different from Unit 61.1B and 61.1C. The diameter limit prescription of cutting all trees smaller than 7" dbh, resulted in a thinning from below approach in a young forest. This diameter limit prescription also allowed for co-dominant trees 7" or greater in dbh that are growing well and close together to remain unthinned. Post treatment information for Unit 61.1A is provided in Table 59 and a map of unit 61 is located in Appendix A.

Table 59. Unit 61.1A 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	130
silver fir, 7 - 13"dbh	70
Noble fir, 11 - 13" dbh	20
Western hemlock, 9 - 10" dbh	40

*sample information: five plots were measured.

Unit 61.1B

The prescription for Unit 61.1B, requiring the contractor to install fourteen gaps on a grid-like pattern per acre, was intended to create a variable tree spacing effect; in other words, this type of prescription was intended to have an effect that did not look at all like a traditional 12x12 spacing etc. There are areas within this Unit that are not very productive due to soils, available moisture, topography and exposure. The results were variable: on one hand, the trees are small in both height and diameter in these low productivity areas with this prescription resulted in the appearance low numbers of residual trees; on the other hand, there are also areas within this Unit where the trees are growing more vigorously, based on tree size and density. In these higher density areas this prescription did produce a variable thinning pattern. This variable thinning pattern may result in a higher level of canopy complexity as this forest develops. This prescription does not lend itself well to traditional forest summary data; however a summary is provided in Table 60. The presence of alder in this Unit does increase the overall trees per acre. A map of unit 61 in located in Appendix A.

Table 60. Unit 61.1B 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	629
silver fir, 1 - 6"dbh	207
Noble fir, 7 - 9" dbh	14
Western hemlock, 4 - 7" dbh	22
Alder, 1 – 4" dbh	386

*sample information: seven plots were measured.

Unit 61.1C

Like Unit 61.1A, because of the difference in tree size, Unit 61.1C was defined as a separate unit. The trees in 61.1C are a bit larger than those found in the unit directly to the north. A species specific diameter limit prescription was designed for this unit , with a cut no western hemlock larger than 3" dbh and cut no silver fir larger than 5" dbh. The result was a unit that still had trees spaced close together. A prescription that had larger diameter limits may have been more appropriate; however in the landscape context of Unit 61, this unit provides a more dense forest compared with other thinned units. Post treatment summary information for Unit 61.1C is included in Table 61 and a map of Unit 61 is located in Appendix A.

Table 61. Unit 61.1C 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	363
silver fir, 4 - 8"dbh	194
Noble fir, 11 - 15" dbh	25
Western hemlock, 4 - 9" dbh	131
Alder, 2 – 4" dbh	13

*sample information: eight plots were measured.

Unit 61.2

Based on average tree height summaries, LiDAR data did not include this area in the restoration thinning candidate pool. Knowing that the access roads near this unit were on the decommissioning list and the trees seemed a reasonable size for restoration thinning, the project team chose to include it as part of Unit 61. For the purpose of improving canopy complexity, six $1/5^{th}$ acre gaps with different configurations of leave trees (one, two and three leave trees) were prescribed. The vision regarding these gaps with trees left in the center is that these center trees may develop more dominant tree canopy characteristics, and the gap edge

trees may develop more dominant canopy characteristics as well. In addition six 1/5th acre skips were prescribed. These skips should also contribute to canopy complexity. The remaining area in Unit 61.2 was prescribed to be 194 trees per acre. The post-treatment average trees per acre is higher because of a diameter limit prescription (10" dbh). Post treatment summary information for Unit 61.2 is provided in Table 62 and a map of Unit 61 is located in Appendix A.

Table 62. Unit 61.2 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	390
silver fir, 5 - 11"dbh	250
Noble fir, 7 - 10" dbh	30
Western hemlock, 4 - 13" dbh	50
Western red cedar, 1" dbh	20

*sample information: nine plots were measured.

Unit 61.3

Like Unit 61.2, Unit 61.3 was not identified by LiDAR data as a restoration thinning candidate; however due to road decommissioning plans and no ecological thinning planned for this area in the future, the project team chose to include it as part of Unit 61. Because of the larger tree size, a diameter limit prescription was prescribed for this Unit. All trees smaller than 8"dbh were to be cut, essentially performing a restoration thinning from below. The post-treatment summary information for Unit 61.3 is provided in Table 63 and a map of Unit 61 is located in Appendix A.

Table 63. Unit 61.3 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	183
silver fir, 10 - 11"dbh	33
Noble fir, 10" dbh	17
Western hemlock, 9 - 13" dbh	133

*sample information: three plots were measured.

Unit 61.4A

To introduce canopy heterogeneity at a larger scale than was occurring naturally, ten skips and ten gaps were prescribed in Unit 61.4A. These skips and gaps varied in size between 1/10th acre and 1/5th acre. The locations of the skips and gaps were scattered throughout the Unit. This Unit had a tree spacing prescription of 134 trees per acre. The post-treatment summary information for Unit 61.4A is provided in Table 64 and a map of Unit 61 is located in Appendix A.

Table 64. Unit 61.4A 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	133
silver fir, 3 - 9"dbh	72
Noble fir, 3 - 10" dbh	50
Douglas-fir, 7" dbh	6
Western hemlock, 8" dbh	6

*sample information: nine plots were measured.

Unit 61.4B and 61.4C

These two units were sub-divided out of the larger Unit 61.4 A because of their larger tree size composition. Both of these units are bi-sected by a forest road, so perhaps, as a result of the road installation they were harvested earlier than Unit 61.4A. Because of their larger tree size, a diameter limit prescription was prescribed. This type of prescription respects larger trees that are growing closely together, for example, two eight inch dbh silver fir that are growing right next to each other would not be cut. The thinning related slash in these units was required to be lopped. The post-treatment summary information for Unit 61.4B and 61.4C is provided in Table 65. The forest created from this prescription

should continue to evolve with a higher tree density than the tree density in the surrounding Unit 61.4A. A map of Unit 61 is located in Appendix A.

Table 65. Unit 61.4B & 61.4C 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	235
silver fir, 7 - 13"dbh	142
Noble fir, 8 - 10" dbh	34
Douglas-fir, 9 - 13" dbh	25
Western hemlock, 9 - 12" dbh	34

*sample information: six plots were measured.

Unit 61.5

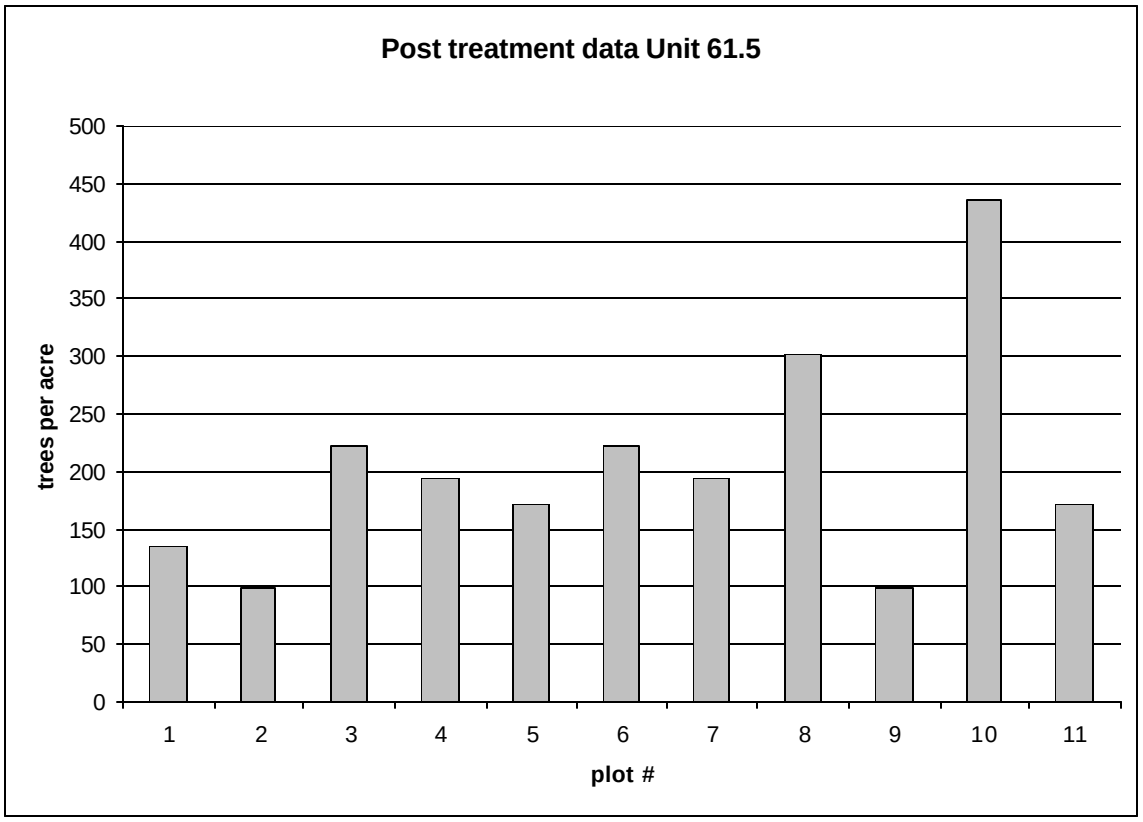
The prescription in Unit 61.5 was fairly complex, including circular skips and gaps, linear skips and two different spacing prescriptions. The linear skips were designed for two differing reasons. The westerly linear skip was designed to provide an undisturbed connection between the older forest (old growth) to the south and the wetter Unit 61.6 (leave). The easterly linear skip was designed to provide an undisturbed area adjacent to the stream that flows through Unit 61.5. The areas within Unit 61.5 that lie east and west of these stream skips have a 194 tree per acre spacing prescription. The area between these two stream skips have a variable spacing prescription. This variable spacing prescription intended the spacing of trees to range between 1,740 trees per acre and 70 trees per acre. The contract thinners did have difficulty interpreting this variable prescription, resulting in very little to no areas that meet the 1,740 trees per acre threshold with most of the middle of this unit falling in the 194 trees per acre range. Summary information regarding trees per acre is provided in Graph 1. The post treatment summary information for Unit 61.5 is provided in Table 66. A map of Unit 61 is located in Appendix A.

Table 66. Unit 61.5 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	204
silver fir, 4 - 10"dbh	204

*sample information: eleven plots were measured.

Graph 1: Post treatment data Unit 61.5 by individual trees per acre by plot



Unit 61.6
This thirty-three acre unit has a high density of wetland features. The project team decided that allowing this area to continue to develop undisturbed by any restoration thinning activity was an ideal approach. Future plans to decommission the 250.3 road will rehabilitate the connection between Unit 61.6 and Unit 61.1B. No treatment was performed in Unit 61.6; however its location and appearance can be observed in the map of Unit 61 located in Appendix A.

Unit 61.7
A large skip area was part of the prescription for Unit 61.7. This skip is intended to promote the undisturbed development of a forested wetland. For the purpose of diversifying the current tree canopy, six $1/10^{th}$ acre gaps were installed. The remainder of the unit was thinned to 134 trees per acre. This spacing is intended to add diversity to the Unit 61 landscape as the Unit to the east of Unit 61.7 (Unit 61.11) and the Unit to the west of Unit 61.7 (Unit 61.6) are basically un-thinned. The post-treatment summary information for Unit 61.7 is provided in Table 67 and a map of Unit 61 is located in Appendix A.

Table 67. Unit 61.7 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	117
silver fir, 3 - 7"dbh	92
Noble fir, 7 – 10" dbh	25

*sample information: six plots were measured.

Unit 61.8
A stream and associated wet meadows flows through the middle of Unit 61.8. This unit has two different tree spacing prescriptions because the trees growing on the slope east of this stream are larger in height and diameter when compared to the trees growing on the slope west of this stream. The east side of this unit, where the trees are larger, has seven $1/5^{th}$ acre treed gaps installed. The gaps are considered treed because the largest tree available located near the center of the gap was not cut. This center tree ideally will develop

dominant tree characteristics over time. The gap edge trees may develop dominant tree characteristics as well. Additionally, within these gaps, all trees (except the center tree) that were 8" dbh and larger were required to be girdled by the contractor. In the near term, these girdled trees may provide foraging opportunities for birds and perhaps secondary cavity nesting opportunities for the smaller birds. The west side of Unit 61.8, where the trees are smaller and younger had a spacing requirement of 170 trees per acre. Additionally, nine skips were installed.

The stream that flows through the center of the unit had a variable skip requirement. The project team did not want to limit riparian area tree growth by imposing a skip that ran the total length of the stream because tree size often increases in riparian areas and lack of large woody debris in and near these streams (because of the way the area was logged). The project team also felt that skips along streams were important to provide undisturbed habitat for stream dependant wildlife. To promote both riparian area tree growth and undisturbed riparian habitat, a skip was required on 2/3rds of the stream riparian area, with the remaining 1/3rd requiring the spacing prescription. Additionally, no skip was required on the tributary streams flowing through the west side of Unit 61.8 and into this larger centrally located stream. The spacing prescription for the Westside of Unit 61.8 is 170 trees per acre. The post-treatment summary information for the westerly portion of Unit 61.8 is provided in Table 68 and a map of Unit 61 is located in Appendix A.

Table 68. Unit 61.8 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	217
silver fir, 3 - 6"dbh	133
Western hemlock, 3 – 6" dbh	67
Western red cedar, 5" dbh	17

*sample information: three plots were measured.

Unit 61.9

Unit 61.9 is in close proximity to unique habitats including older forest edges (old growth to the south and west, open pond area (unit 61.9 surrounds pond) and wet meadows (adjacent to unit 61.9 boundaries and in near vicinity of unit). The linear skip located in the approximate center of Unit 61.9 is intended to provide undisturbed protection for amphibians that may move from the pond area into the unit or towards wet meadows. Four other skips were installed to provide near term undisturbed habitat. The vision with these skips, and skips in general, installed at this stage in the forests development is that over time the trees that occupy these skips will decrease in vigor (except for perhaps the edge trees) and eventually these skips may become gaps, or go through a snag stage, or provide a later input of coarse woody debris to the stand, or evolve into a secondary co-hort of trees (when the original skip trees die). In short, the evolution of skips is assumed to be variable. Two large gaps and four smaller gaps are providing variability in the near term canopy structure, and ideally will provide opportunities for canopy variability over time. The remaining forest has two different tree spacing prescriptions: 170 trees per acre and 134 trees per acre. The post-treatment summary information for Unit 61.9 is provided in table 69 and a map of Unit 61 is located in Appendix A.

Table 69. Unit 61.9 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	142
silver fir, 3 - 8"dbh	125
Western red cedar, 1" dbh	17

*sample information: six plots were measured.

Unit 61.10

Headwaters of streams are unique and subtle on the landscape. A buffer around the headwaters of the stream that originates in Unit 61.10 coupled with a linear skip that is perpendicular to these headwaters may provide undisturbed habitat for moisture dependant wildlife to forage and reproduce. Skips and gaps were incorporated into the prescription to provide near-term canopy variability. The spacing prescription is 134 trees per acre. The post-treatment summary information for Unit 61.10 is provided in table 70 and a map of Unit 61 is located in Appendix A.

Table 70. Unit 61.10 2008 post-treatment information

Type	Average number of trees per acre
Total number of trees	125
silver fir, 4 - 7"dbh	75
Noble fir, 7 – 8" dbh	50

*sample information: four plots were measured.

Unit 61.11

The trees that make up the developing forest in Unit 61.11 were considered by the project team (and LiDAR) to be too tall to restoration thin for safety reasons. The two access roads for Unit 61.11 (208 Road and the 207 Road) are due to be decommissioned. Unit 61.11 is not being planned for an ecological thinning now or in the future. For these three reasons, tree size, road decommissioning, and no future activity planned, the project team decided it would be appropriate to include Unit 61.11 with an non-spacing prescription in restoration thinning for 2008. The prescription for this unit is called snag –gaps. The prescription introduced snags by requiring girdling of larger diameter trees in designated gap locations, leaving the best available green tree in the center of the gap. This sort of prescription does not lend itself well to post-treatment data summary. A map of Unit 61 is included in Appendix A.

Unit 61.12

The project team incorporated a variable tree spacing prescription in Unit 61.12, similar to Unit 61.5. The tree spacing variability called for in the prescription was 435 trees per acre, 194 trees per acre and 109 trees per acre. The desired intent is that spacing should vary from tree to tree. In both Unit 61.12 and Unit 61.5 the thinners had a difficult time leaving the tighter spacing (435 trees per acre); however the variability appeared closer to the prescription intent in Unit 61.12. Five 1/5th acre skips were prescribed in this unit as-well. No post-treatment data was collected for this unit. A map of Unit 61 is included in Appendix A.

Summary Information about Skips and Gaps

Incorporating areas of no disturbance (skips) and areas where all trees are cut (gaps) was considered for all of the 2008 restoration thinning units. Not all the 2008 units had skips and/or gaps as part of the unit prescriptions for the following reasons: small unit size, taller tree size, naturally 'gappy', future experiment planned, and snow gap placement In summary regarding the skips, 36% of the 2008 restoration thinning units had no skips (with 64% of the units having skips). The skip density within a unit ranged from 4% of the unit acres committed to skips to 100% of the unit acres committed to skips (indicating a leave unit). In summary regarding the gaps, 41% of the 2008 restoration thinning units had no gaps (with 59% of the units having gaps). The gap density within a unit ranged from 1% of the unit acres committed to gaps to 33% of the unit acres committed to gaps (indicating a snow gap unit). A summary percentage of skips and gaps by unit can be found in Table 71.

Table 71. Percentage of Skips and Gaps by Unit

Unit #	acres	% in skip	% in gap
9.1	15	11%	0%
9.2	10	100%	0%
9.3	5	10%	0%
18.1	39	10%	14%
18.2	43	17%	6%
18.3	10	0%	0%
18.4	33	0%	0%
24.1	5	6%	6%
24.2	33	6%	5%
24.3	13	8%	8%
24.4	3	0%	0%

24.5	4	5%	5%
24.6	9	4%	1%
24.7	2	0%	0%
24.8	22	0%	0%
24.9	15	7%	0%
36.1	8	4%	10%
36.2	25	10%	6%
36.3	15	13%	5%
36.4	2	15%	0%
61.1a	8	0%	0%
61.1b	35	18%	23%
61.1c	23	9%	0%
61.2	23	5%	5%
61.3	3	0%	0%
61.4a	28	5%	5%
61.4b	2	0%	0%
61.4c	4	0%	0%
61.5	30	20%	4%
61.6	33	100%	0%
61.7	13	30%	5%
61.8	78	9%	2%
61.8a	4	0%	25%
61.8b	3	0%	33%
61.8c	3	0%	33%
61.8d	3	0%	33%
61.8e	4	0%	25%
61.9	16	9%	5%
61.1	11	15%	5%
61.11	56	7%	8%
61.12	14	7%	0%
imagine	35	0%	11%

Lessons Learned

Lessons learned refers to knowledge and experience gained relative to the 2008 Restoration Thinning work. There are two parts to lessons learned: 1. Internal ecosystems team lessons learned; and 2.External hired contractor lessons learned.

Internal Ecosystem Team Lessons Learned

- Communication, as mentioned in previous years, appears to be the key for creating a successful project. In 2008, communication within the Ecosystems section went smoothly. People within the Ecosystem Section who have, in the past, provided feed back regarding restoration thinning prescriptions were provided more one-on-one information. For example, one member of the project team did a one-on-one explanation of the units and prescriptions to the Fish & Wildlife Group lead. This careful approach worked well for internal communications evaluating and incorporating suggested changes at the project team level.
- Communication with the contractors could improve in two areas. All restoration thinning contract work requires that a pre-work meeting occurs. Details regarding working in the CRW are reviewed, prescriptions are discussed for greater understanding and clarity, and a work schedule is provided to the CRW project manager by the contractor. There were three different

restoration thinning contractors in 2008; therefore, there were three different pre-work meetings. Two of these pre-work meetings were attended by the contractors who would actually be doing the work on the ground, one of these pre-work meetings was attended by a contractor who did not do any of the thinning work. Communication problems occurred in the latter pre-work. While discussions of complex prescriptions and how they should be implemented occurred at this pre-work, this information was not transferred to the foreman. Because of this lack of information transfer, additional explanations and examples of what was intended had to occur while some of the thinning units were being cut and mistakes had to be remedied. The assumption is that if the foreman had been in attendance at the pre-work, perhaps a route for successfully implementing the prescriptions would have been understood. *Note: specifically this occurred in Unit 61.5*

- Communication with the compliance contractors is critical to the success of the project. Including these folks as participants in the pre-work meetings, coordinating schedules and keeping up to date with all issues relating to restoration thinning is critical. The project manager and contracted compliance person (Jesse Saunders) shared compliance responsibilities in 2008 because of the condensed restoration thinning season and the need to cover a lot of ground quickly. There were several times in early November that access to the units was limited due to snow, communication about current conditions is important both to the compliance contractor and the project manager. Jesse was also tasked with assisting CRW ecologists with installation of a riparian experiment and compliance on restoration planting. Because of good communication, Jesse was aware of these projects, able to shift priorities and happy to help out.
- The 2008 field season was problematic because of weather, weather related access issues and potential habitat sensitivities. The CRW was still experiencing snow at low elevations in April 2008. This snow prevented access to all restoration thinning units until August. (in previous years, restoration thinning contractors are typically active in May or June). Several road blocking snow related avalanches limited all access to the Lindsay Creek basin, where 83% of the 2008 restoration thinning units exist. Eventually the access roads into the Lindsay basin were plowed by the CRW operations crew, and the avalanche debris was cleared from the roads (late July). All of the North Fork Cedar River units had a limited operational window to minimize disturbance to nesting marbled murrelet and northern goshawks (0.25 miles). The majority of the Lindsay Creek Basin units also had a limited operational window because of nesting marbled murrelets within 0.5 miles. These wildlife related operational restrictions allows chain saw use after August 31.
- As we incorporate more complexity into the prescriptions, traditional compliance sampling methods may not capture the results we intended; in fact these traditional sampling methods may not be applicable. Determining how to sample complex prescriptions efficiently and effectively continues to be challenging.
- An individual devoted exclusively to flagging boundaries was valuable in 2008. With forty-five separate units, there were abundant boundaries to flag. All of 2008 restoration thinning unit boundary flagging occurred in 2008, and subject to the same access constraints. The units were ready to go, with obvious flagging and tagging when the contracts were awarded. It is preferable to have the boundaries flagged prior to the thinners beginning a unit so that compliance time can be spent inspecting the thinning work rather than flagging boundaries.

External Compliance Contractor Lessons Learned 2008

- The new 2008 format for the unit prescription sheets is greatly improved in both presentation and content. The objectives of each unit are made clear at the top, which helps both the compliance contractor and the thinning crew understand the planning behind the work to be done.
- Electronic data collection was designed this year by the contractor. It is based in pocket excel for maximum versatility among field users and ease of transfer to the SPU "Fims" inventory system that will hold the data. Data collection can be done on the same machine used in the field to collect GPS points at each plot, or any handheld device that runs pocket excel. The

design includes both on screen compliance calculations and TPA status by species calculated in real time as data is collected. This streamlines data transfer and improves efficiency, as well as giving the compliance contractor instant glance of compliance status while in progress.

- A separate compliance method to capture the frequency of the skip and gap installations was also included in the data collection design. Skip and gap tally points were collected at each plot and at points midway between plots with a minimum of 10 tally points per unit with skips and gaps.
- Flagging is generally not needed where a unit boundary is represented on the ground by a good physical boundary. There were a few cases again this year where physical boundaries such as brushy areas or gentle slope breaks were used without flagging. In these few cases it could be seen on a map but very difficult for the thinning contractor to determine on the ground. The thinning crew recognized that they could easily cut outside the unit, so they requested that it be flagged before they start. It would be best to have units always flagged unless bounded by a road or a defined timber type change.
- The thinning contractors have improved since the beginning of last year in areas of measuring slope distance and using a compass correctly to lay out skips and gaps on a grid. Also skip and gap size with respect to horizontal distance on steep slopes was done correctly this year by the contractor that was struggling last year.
- It continues to be important to check skip and gap sizes to be sure they are as prescribed. It was obvious upon inspection within units of different contractors, which contractors were being consistent by measuring skip and gap size and which were not. I enjoyed working through the challenges with the contractor that I was not familiar with.
- The thinning crew to compliance contractor relationship is important to the successful outcome of the thinning prescriptions. All of the contractors I have worked with so far have had experience with the unique SPU prescriptions. If new thinning contractors are hired in the future, extra attention will be needed to establish the working relationship and let the contractor become familiar with the compliance procedures and open communication set in place.

Citations

Chapin, David; Antieau, Clay; Beedle; Dave; Boeckstiegel; Joselyn, Mark. 2004. Ecosystem Restoration and Management Philosophy for the Cedar River Watershed Habitat Conservation Plan. Science Information Catalog

Erckmann, James. 2006. Landscape Synthesis Plan for the Cedar River Watershed

LaBarge, Amy. 2008 Upland Forest Restoration Strategic Management Plan

Location of plot level data:
J:\USM\ws781\secure\forest ecology unit\restoration thinning\2008 thinning\2008 rt data\2008 restoration thin compliance

Appendix A 2008 Restoration Thinning Unit Maps

Folder located on J:\USM\WS781\Secure\Forest Ecology unit\Restoration Thinning\2008 thinning\2008 unit prescriptions and maps\2008 unit maps\2008 restoration thinning maps

Appendix B 2008 Restoration Thinning Contract

Folder located J:\USM\WS781\Secure\Forest Ecology unit\Restoration Thinning\2008 thinning\2008 contract\restoration thinning contract

Appendix C Imagine Unit, 2008 Benefits for Elk Habitat

The Imagine Unit currently consists of a very dense (>10,000 trees per acre) young forest dominated by western hemlock trees. The thinning prescription will cut most of the hemlock, leaving a stand dominated by Douglas-fir and western red cedar. There is a small forested wetland adjacent to the unit and across the 70 road, and the headwaters of a small stream that flows out of the north end of the unit. Wet areas are favored by elk, and these small habitat patches may bring elk close to the site where forage opportunities will be provided. This area has had historically low elk use in the past 30 years, however, as documented by SPU staff in the 1980s.

Units 1.1A and 1.1B (17 acres total) will be thinned to about 130 trees per acre, which should provide ample light to the forest floor throughout these units for understory development over the short and intermediate terms. Unit 1.2 (23 acres) will be thinned to about 190 trees per acre, to provide variable density on a larger spatial scale. Two small skip areas will be left in Unit 1.2. These skips, along with the gaps discussed below, will provide variable density on a small spatial scale.

Once the thinning is complete, the three spur roads within the unit will be decommissioned and planted to deciduous trees and shrubs, to provide long-term conifer canopy gaps and to try to avoid the carpet of small hemlock that would likely develop if no planting occurred. The understory that develops under a deciduous canopy could include a diversity of forbs and shrubs that are eaten by elk. If alder comes in too densely to allow understory shrub and forb development, we will thin them as needed in future years.

Seven 0.25 to 0.5-ac gaps will be installed throughout the unit. As with the spur roads, these gaps will planted to deciduous trees and shrubs (including big-leaf maple) to create a longer-lasting gap that will not be overcome by dense hemlock regeneration. Several of these gaps are located adjacent to the spur roads or existing older forest, to allow elk easier passage to these forage areas. Gaps that are located within the center of the unit will have small travel corridors linking them to each other or a spur road. These travel corridors will be up to five feet wide and trees will be directionally felled away from them, with slash lopped and piled where necessary. These corridors will provide elk with an easy path from forage gap to forage gap.

Appendix D Riparian Experiment in Unit 18

Lindsay Creek Unit 18 Restoration Thinning
Riparian Experimental Treatments

Introduction

The headwaters of Lindsay Creek within Restoration Thinning Unit 18 provide an excellent opportunity to experimentally examine different riparian thinning treatments. Current restoration thinning prescriptions for riparian areas are generally 10x10 ft spacing for 25 feet on either side of the stream, which is considered sufficient to provide root strength to retard bank erosion. Wider spacing would allow for greater potential benefits to streamside riparian areas from thinning treatment. Typical objectives of restoration thinning in headwater riparian areas include:

- Contribute to forest structural complexity within surrounding upland forest
- Increase growth rate of riparian trees to provide larger LWD sooner
- Increase understory biomass and diversity.
- Enhance habitat for stream-dwelling amphibians.

There are several lower gradient streams in Unit 18 with relatively similar conditions, where replicate treatments could be set up without much risk of bank erosion. This experiment would entail applying three different treatments with different spacing and interplanting, along with a no-treatment control. A number of different responses would be measured following thinning treatments to evaluate effects on habitat conditions and tree growth response.

The following questions are to be addressed in this experiment:

1. What is the growth response of trees as a result of each treatment?
2. What are the effects on moisture/temperature in the streamside riparian zone and what is the duration of those effects?
3. How does overstory/understory species diversity and cover change?
4. Is there a change in bank stability and erosion?

Riparian Restoration Thinning Treatments

All treatments would retain the first streamside tree. Treatments would extend 80 feet away from the stream bank or the upper break of an inner gorge. Experimental units (replicates) would be 100 feet of stream reach with the same treatment on both sides of the stream. In addition to a no thinning control, there would be three treatments consisting of:

1. 10x10 ft spacing (435 tpa), as in the typical restoration thinning prescription used in recent past;
2. 18x18 ft spacing (134 tpa), with interplanting of red alder (other species?);
3. 24x24 ft spacing (76 tpa), with interplanting of western redcedar to achieve 18x18 spacing

In all three treatments, slash would be felled away from the stream, lopped and piled to allow interplanting and understory regeneration.

Experimental units would be selected randomly within each of the three streams within Unit 18 with an equal number of each treatment and control for each stream. There is about 5,000 ft of potential stream length available for distributing replicates of each treatment and the control, resulting in up to 50 total replicates. Ideally, this would result in about 12 replicates for each treatment/control, but actual number of replicates may be somewhat less depending on how the experiment is laid out. The experiment would be applied only in stands with tree height less than

<15 ft (estimated 5,000 ft of stream) and with conifer tree dominance, excluding some areas with taller trees mostly in the southeastern portion of the unit.

- Do we need that many replicates? What about having longer replicates?
- Would we exclude from the experimental area any riparian sections that are deciduous or shrub dominated?

Monitoring Variables

To evaluate the effects of the treatments, the following variables would be monitoried:

- Radial growth (tree ring width) – why not dbh?, Will we track growth on planted trees in addition to residual trees?
- Understory cover and species composition,
- Temperature and relative humidity, and
- Bank stability

Monitoring protocols will be developed and added to this study design. Briefly, tree cores collected with an increment borer will be used to measure tree radial growth. Understory structure and microclimate will be measured along transects perpendicular to the stream, with microclimate being measured by mobile sensor/data logger systems (this will likely require purchasing some equipment). Bank stability will be assessed using standard aquatic habitat inventory methods.

Schedule

More detailed site assessment and lay out will occur when snow melts in the spring/early summer 2008. Restoration thinning would be done during summer and interplanting during fall. 2008. Monitoring would begin in summer 2009.

Permitting

An exemption to the Forest Practices Rules will be required.

Appendix E Contractor Bid Prices – Cost of Doing Business in 2008

Unit number	acres	Bid per acre	Total bid per unit
9.1	15	$211.00	$3,165.00
9.3	5	$211.00	$1,055.00
Total	**20**		**$4,220.00**
36.1	8	$275.00	$2,200.00
36.2	25	$275.00	$6,875.00
36.3	15	$275.00	$4,125.00
36.4	2	$275.00	$550.00
Total	**50**		**$13,750.00**
Unit number	**acres**	**Bid per acre**	**Total bid per unit**
18.1	39	$321.00	$12,519.00
18.2	43	$206.00	$8,858.00
18.3	10	$178.00	$1,780.00
18.4	33	$125.00	$4,125.00
Total 18	**125**		**$27,282.00**
24.1	5	$268.00	$1340.00
24.2	33	$197.00	$6505.00
24.3	13	$267.00	$3471.00
24.4	3	$220.00	$660.00
24.5	4	$263.00	$1052.00
24.6	9	$228.00	$2052.00
24.7	2	$164.00	$328.00
24.8	22	$298.00	$6556.00
24.9	15	$184.00	$2760.00
Total 24	**106**		**$24,724.00**
Unit number	**acres**	**Bid per acre**	**Total bid per unit**
61.1A	8	$174.00	$1,392.00
61.1B	35	$174.00	$6,090.00
61.1C	23	$184.00	$4,232.00
61.2	23	$184.00	$4,232.00
61.3	3	$424.00	$1,272.00
61.4A	28	$194.00	$5,432.00
61.4B	2	$424.00	$848.00
61.4C	4	$424.00	$1,696.00
61.5	30	$218.00	$6,540.00
61.7	13	$174.00	$2,262.00
61.8	78	$154.00	$12,012.00
61.8 A,B,C,D,E	17	$232.00	$3,944.00
61.9	15	$210.00	$3,150.00
61.10	11	$204.00	$2,244.00
61.11	56	$54.00	$3,024.00
61.12	14	$218.00	$3,052.00
Total	**360**		**$61,422.00**

Unit number	**acres**	**Bid per acre**	**Total bid per unit**
Imagine	35	$164.00	$5,740.00
roadside slash	5	$290.00	$1,450.00
gap creation and gap	4	$390.00	$1,560.00